

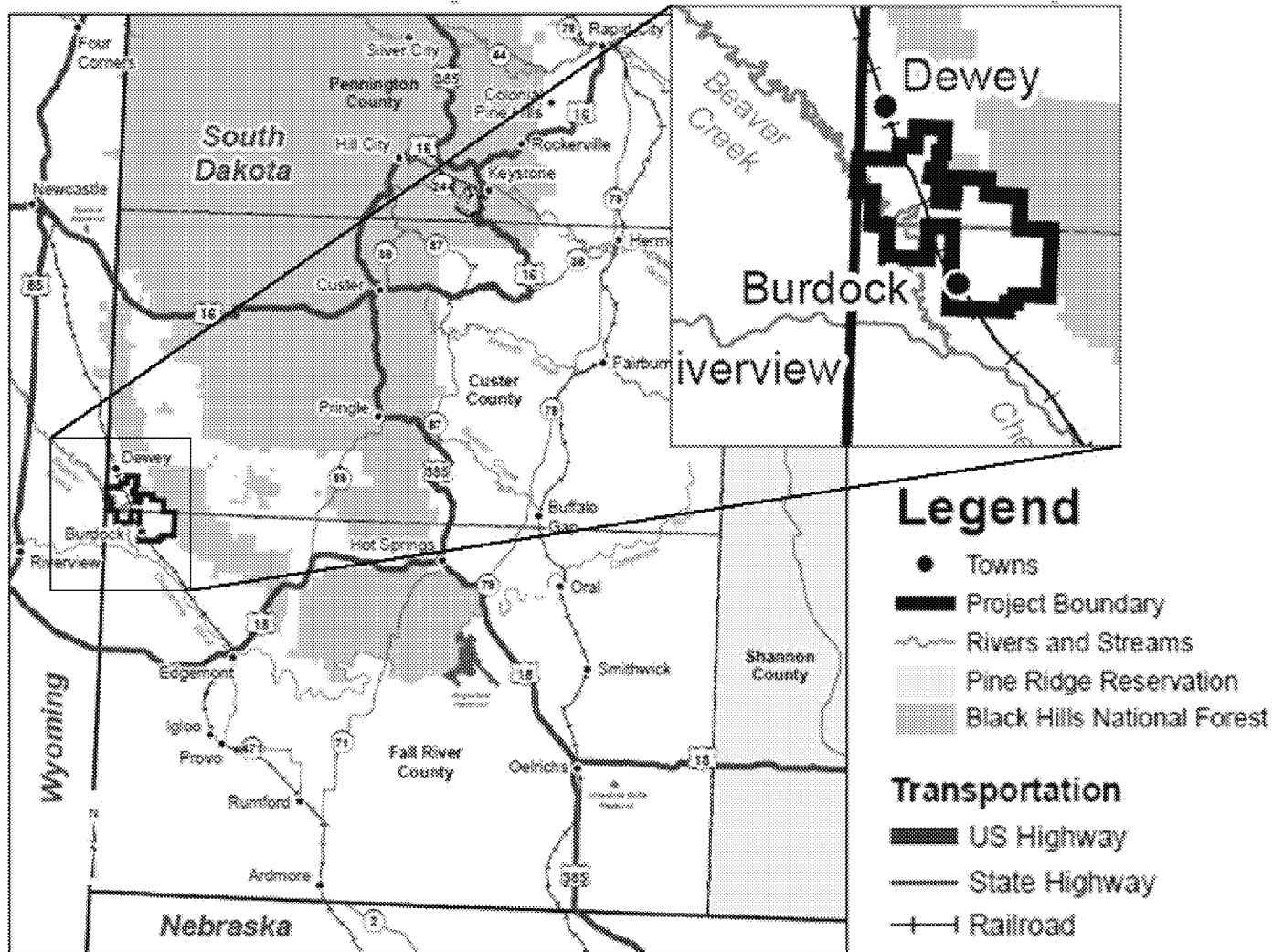
# **U.S. Environmental Protection Agency Underground Injection Control Program**

***Draft Permits and Proposed Aquifer Exemption  
at the Dewey-Burdock In-Situ Uranium Recovery  
Site near Edgemont, South Dakota***

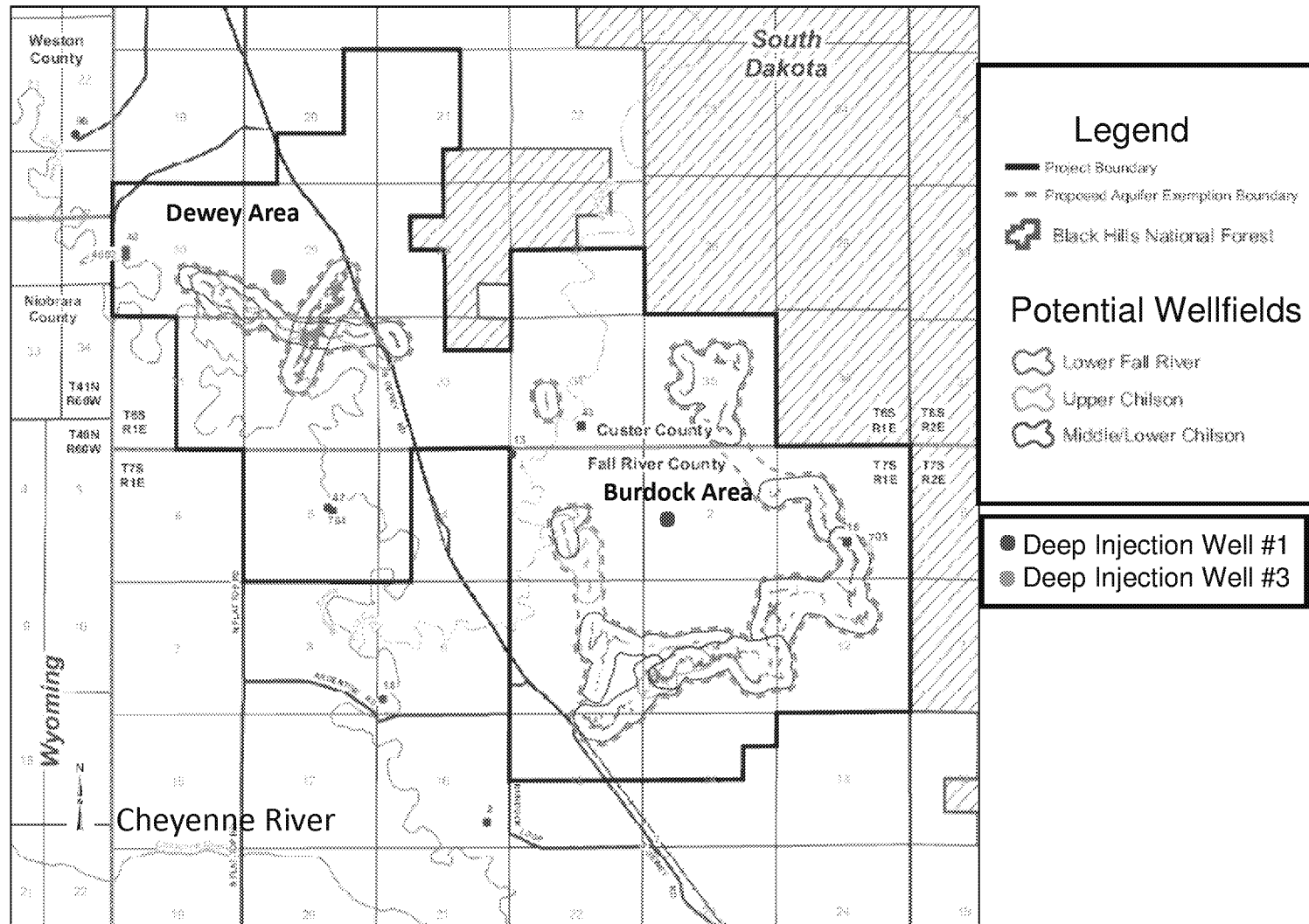
# Background: The Underground Injection Control Program

- Authorized under the Safe Drinking Water Act
- Mission: to protect Underground Sources of Drinking Water by regulating injection activity and injection wells.
- An “Underground Source of Drinking Water” (USDW) is defined by regulation as an aquifer (or portion)
  - Which supplies any public water system; or
  - Which contains a sufficient quantity of ground water to supply a public water system; and
    - Currently supplies drinking water for human consumption; or
    - Contains fewer than 10,000 mg/l total dissolved solids.
- Classifies injection wells under 6 classes based on type of injectate and purpose for injection activity.
  - Class III – injection for in-situ recovery (ISR) of uranium
  - Class V – disposal of treated ISR waste fluids into an aquifer stratigraphically above a USDW.
- May exempt a portion of a USDW from protection under the program based on certain criteria, including if the aquifer contains economically viable hydrocarbon or mineral resources.

# Dewey-Burdock Location Map



## Dewey Burdock Proposed Class III UIC Wellfields, Aquifer Exemption Area and Deep Disposal Wells





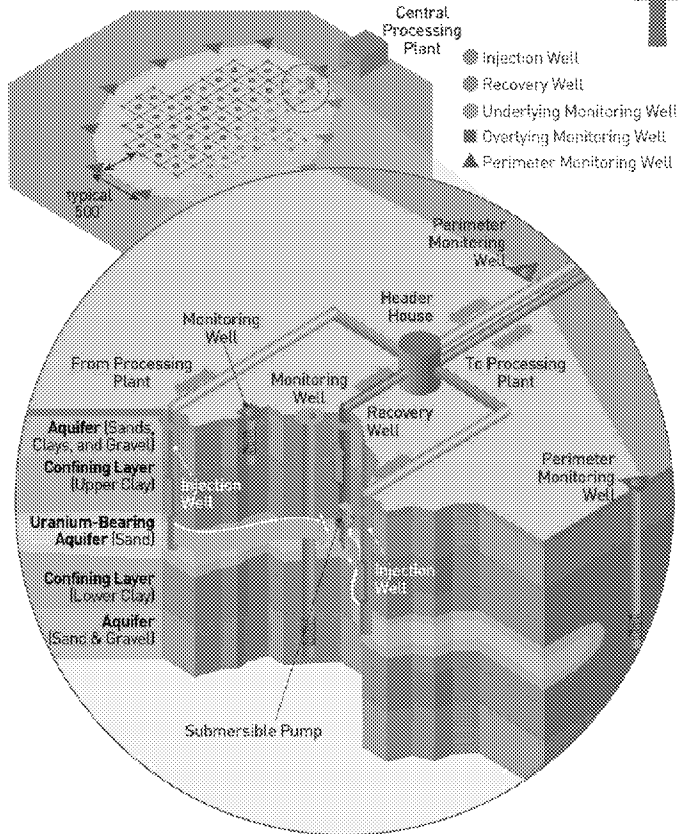
# The Dewey-Burdock UIC Administrative Record

- The Region 8 UIC Program issued two draft area permits on March 6, 2017.
  - One draft permit is a Class III Area Permit for injection wells for the in-situ recovery (ISR) of uranium in Inyan Kara aquifers;
  - The second draft permit is a UIC Class V Area Permit for deep injection wells that will be used to dispose of ISR process waste fluids into the Minnelusa Formation after treatment to meet radioactive waste and hazardous waste standards.
- The EPA also proposed an aquifer exemption approval in connection with the Class III Area Permit to exempt the uranium-bearing portions of the Inyan Kara Group aquifers.
- The EPA also released for public review and comment:
  - a draft Environmental Justice Analysis,
  - a draft Cumulative Effects Analysis, and
  - a draft document explaining process and considerations for Tribal Consultation.
- The public comment period ran from March 6 through June 19, 2017.

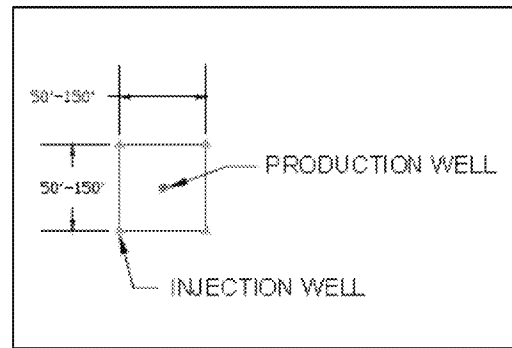
## **Other Regulatory Agencies at the Dewey-Burdock Site**

- The Nuclear Regulatory Commission issued a License for the entire site.
- The South Dakota Department of Environment and Natural Resources has proposed issuance of a Large Mine Permit for the entire site.
- The BLM approved a Plan of Operations for portions of the site on BLM land.
- The South Dakota Department of Environment and Natural Resources has proposed issuance of a groundwater discharge permit for the land application of treated ISR waste fluids.

## The In Situ Uranium Recovery Process



# Typical Wellfield Design and ISR Process

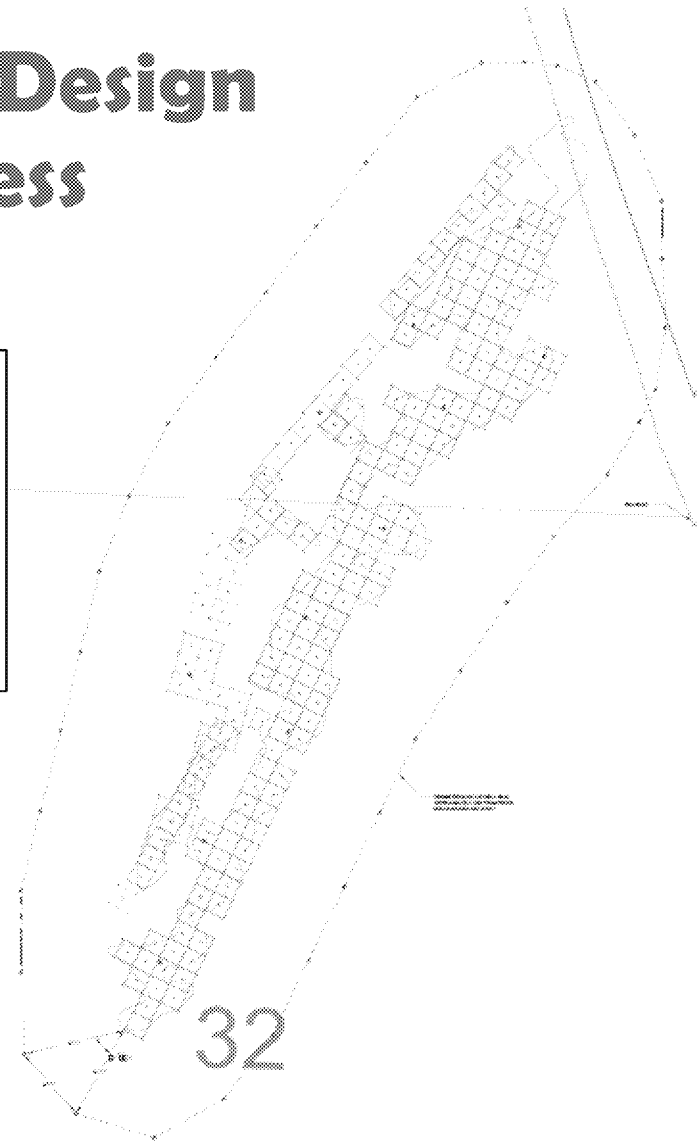


- PERIMETER MONITOR WELL
- OVERLYING MONITOR WELL
- UNDERLYING MONITOR WELL

Injection wells ● pump a solution of native ground water, usually mixed with sodium bicarbonate and oxygen, into the aquifer (ground water) containing uranium ore. The solution dissolves the uranium from the deposit in the ground and is then pumped back to the surface through recovery wells ●, all controlled by the header house. From there, it is sent to the processing plant. Monitoring wells ● ■ ▲ are checked regularly to ensure that injection solution is not escaping from the wellfield. Confining layers keep ground water from moving from one aquifer to another.



As of July 2016



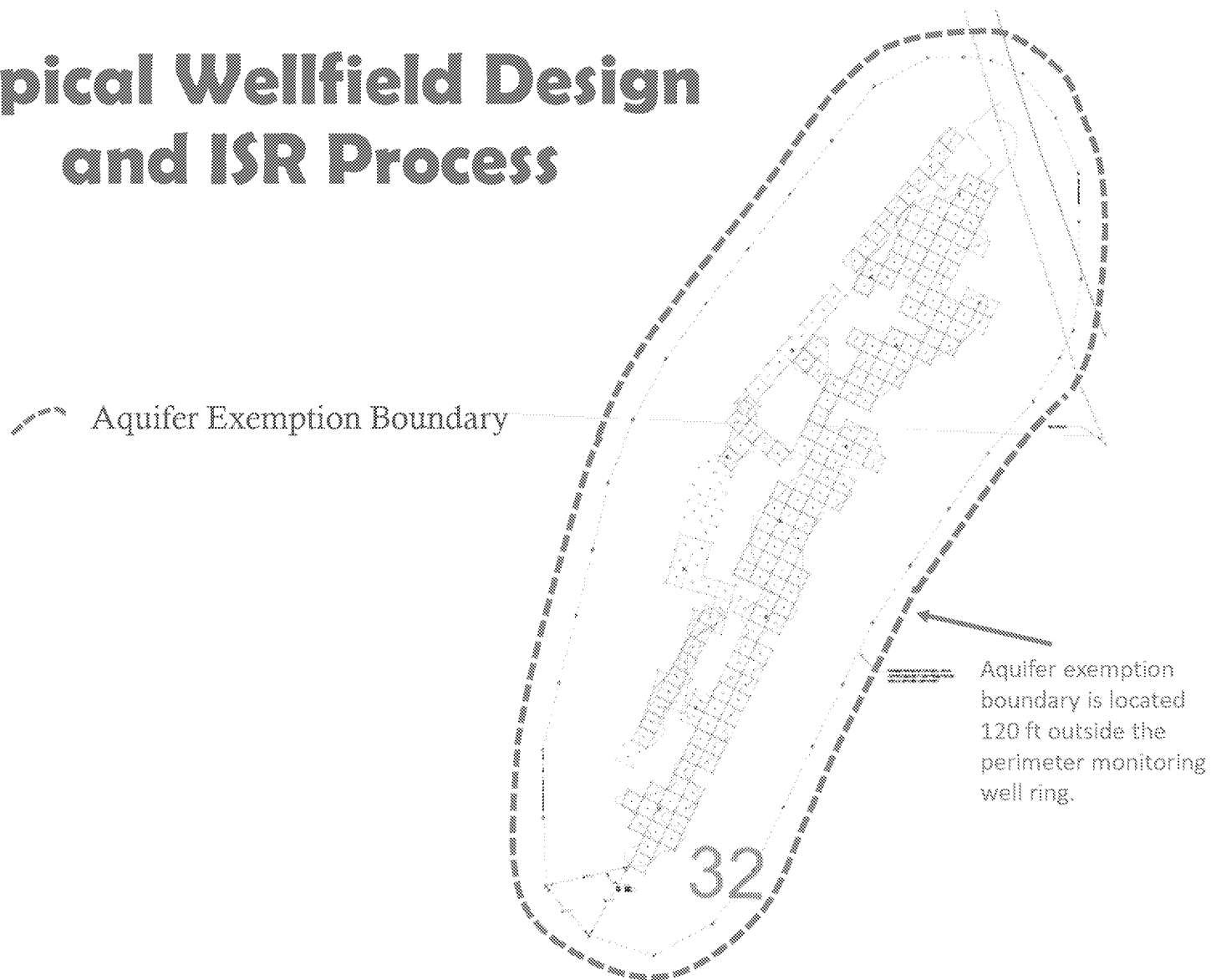
# **The Proposed Aquifer Exemption**

An Aquifer Exemption is required to inject into the Class III wells for uranium recovery.

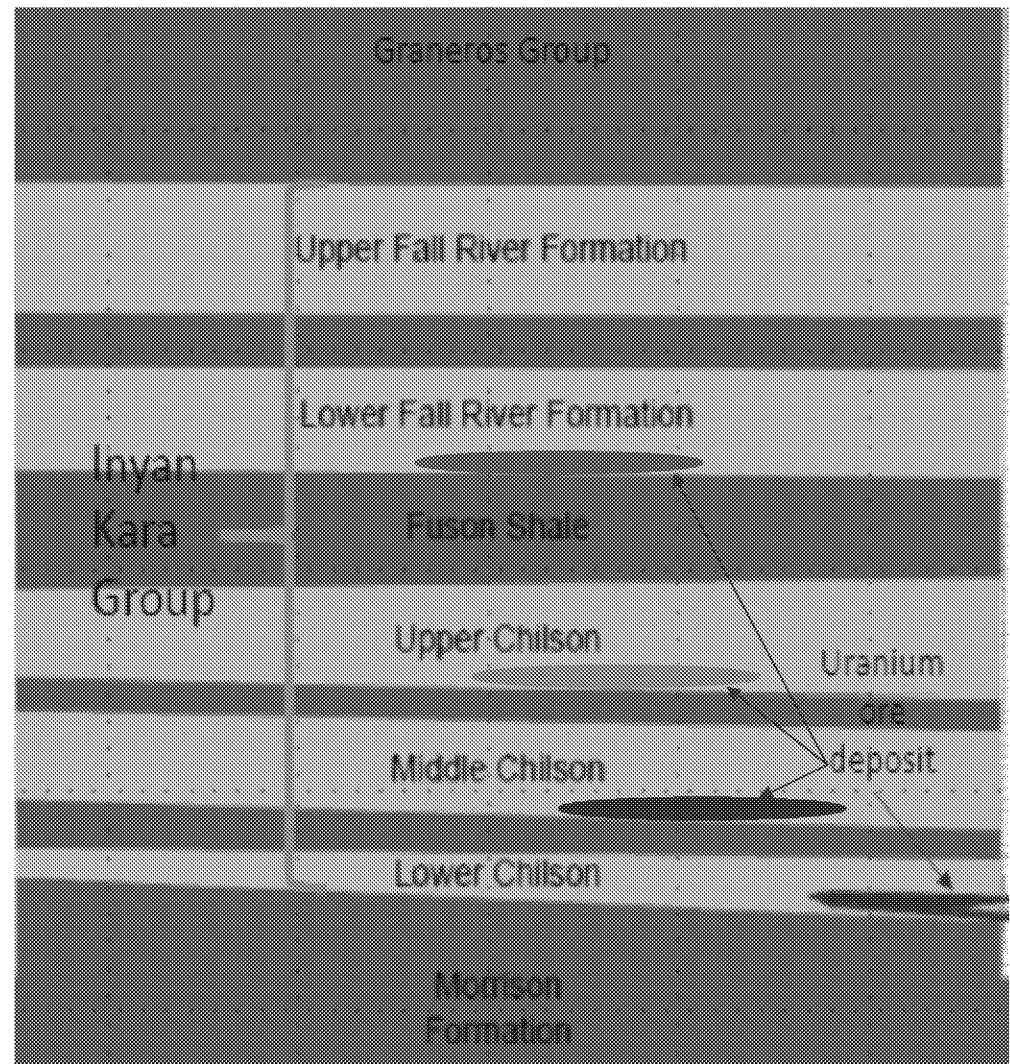
An Aquifer Exemption is allowed under UIC regulations IF the USDW:

1. Does not currently serve as a source of drinking water and
2. Is mineral producing or can be demonstrated to contain commercially producible minerals.

# Typical Wellfield Design and ISR Process



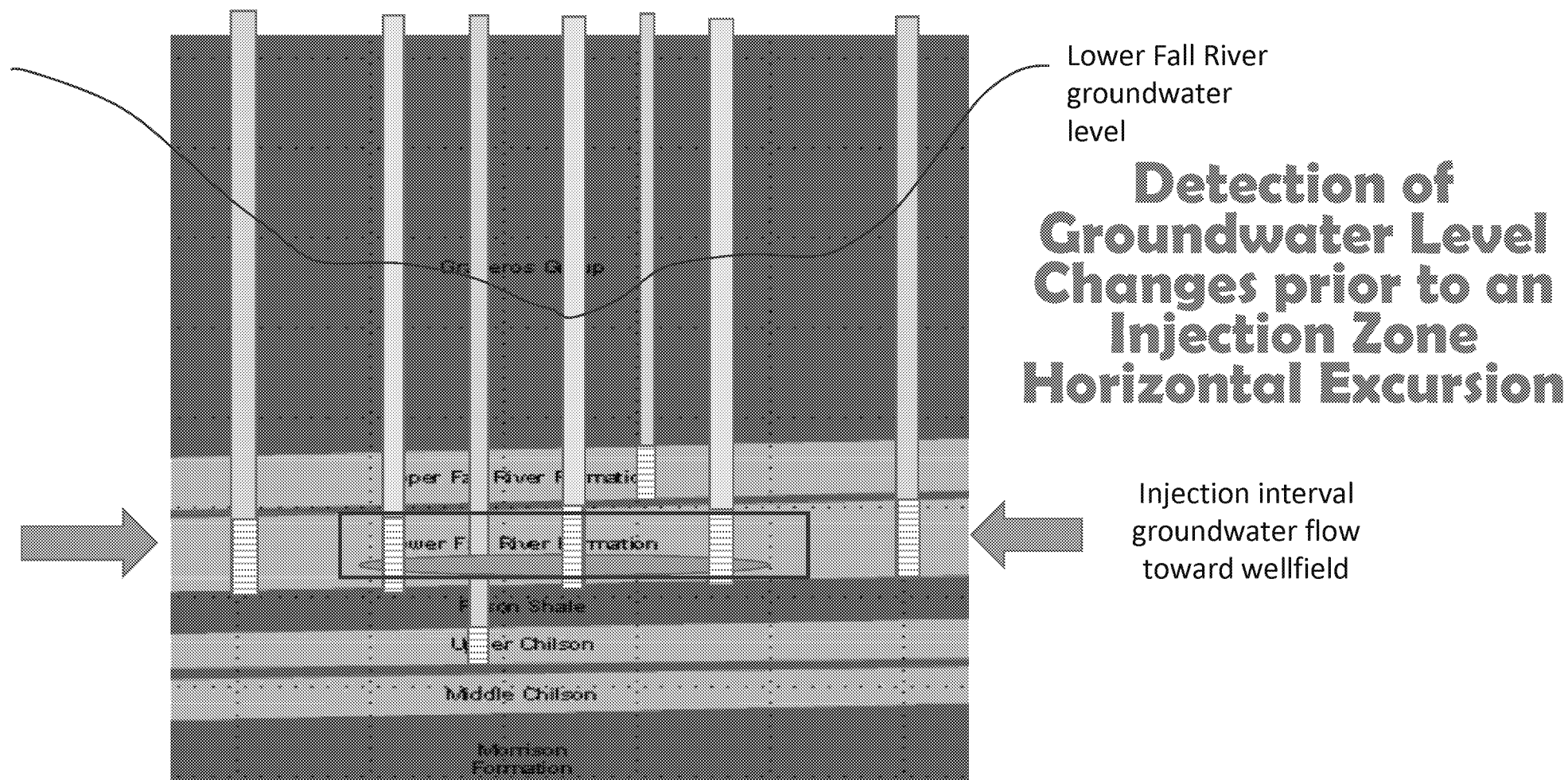
# Vertical Extent of the Aquifer Exemption Boundary



# **Important Draft Permit Requirements**

- Excursion Monitoring
- Post-Restoration Monitoring

# Excursion Monitoring





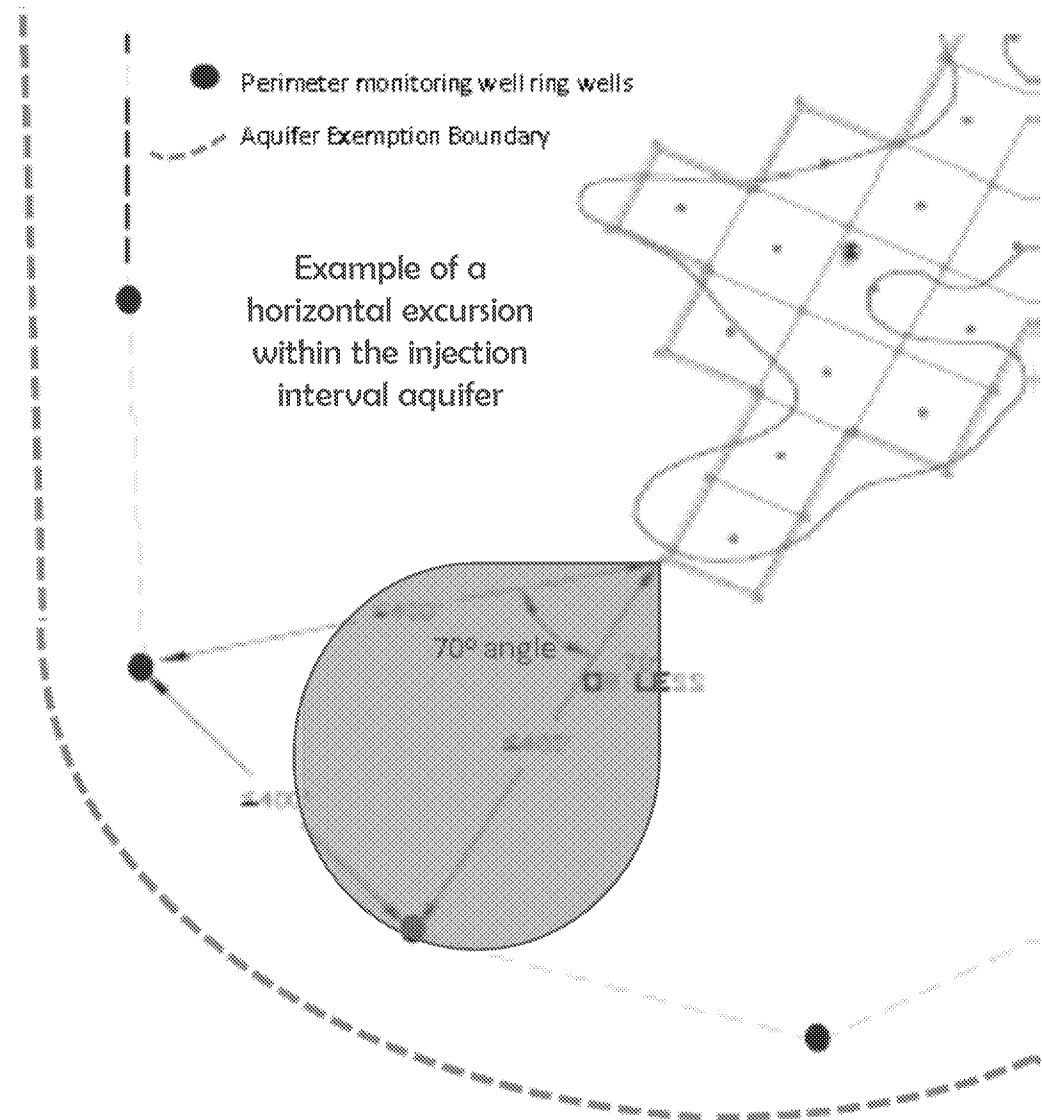
# Excursion Monitoring

When components of the lixiviant move out of the wellfield injection interval area and are detected at the perimeter monitoring wells, the event is called an “excursion.”

The excursion indicators would be chloride, specific conductance and alkalinity.

If an excursion is detected at a perimeter monitoring well, the monitoring frequency of the impacted well is increased to every week until the excursion plume is removed.

The Class III permit requires that the wells impacted by the excursion and the monitoring wells the nearest impacted monitoring wells are sampled every week.

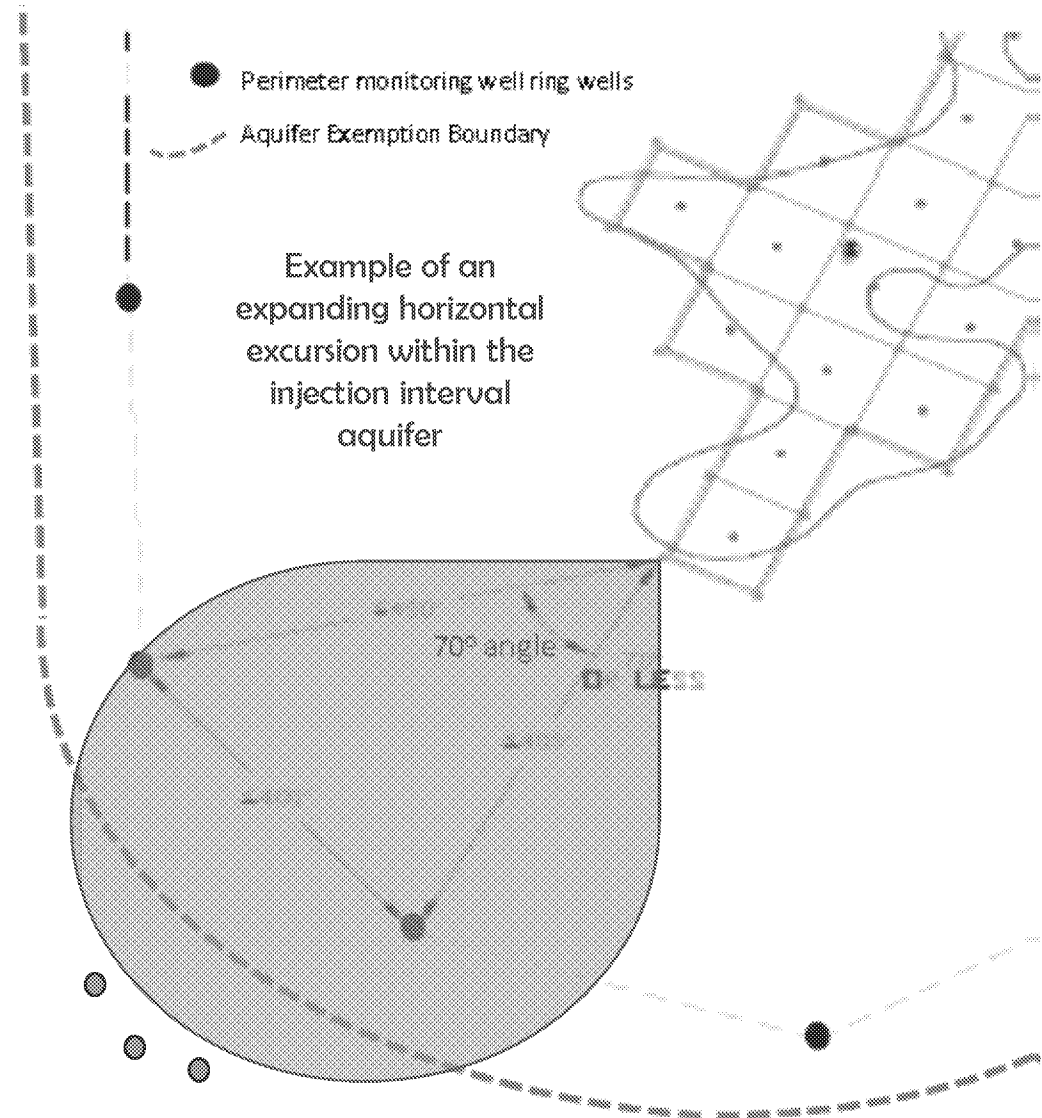


# Excursion Monitoring

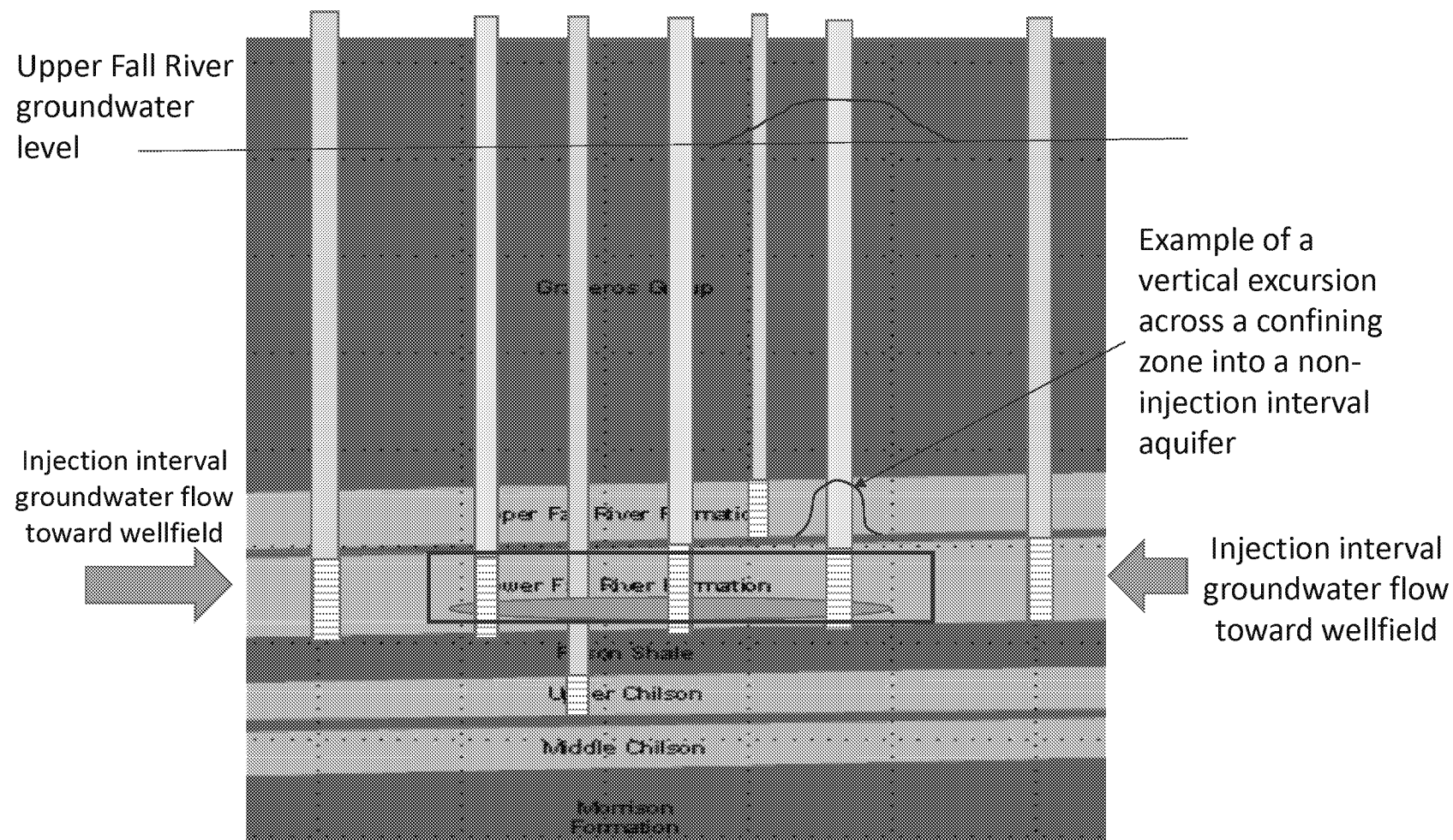
If an “expanding” excursion plume is detected, then the Class III draft area permit requires the permittee to install downgradient monitoring wells to determine if the excursion has crossed the aquifer exemption boundary.

- additional monitoring wells down-gradient of the excursion plume leading edge where groundwater has not been impacted by excursion indicators

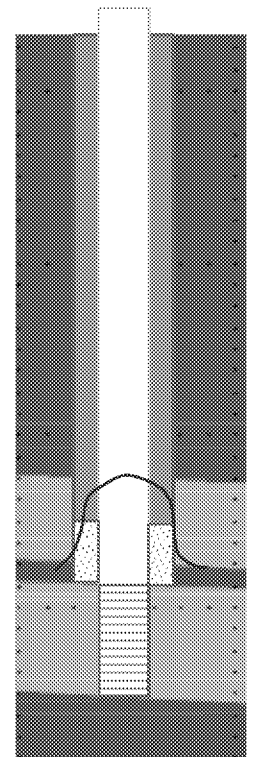
If ISR contaminants cross the aquifer exemption boundary into the USDW, that is a violation of the Class III permit and the permittee would be required to conduct aquifer remediation of the USDW.



# Example of Vertical Excursion



Well construction diagram

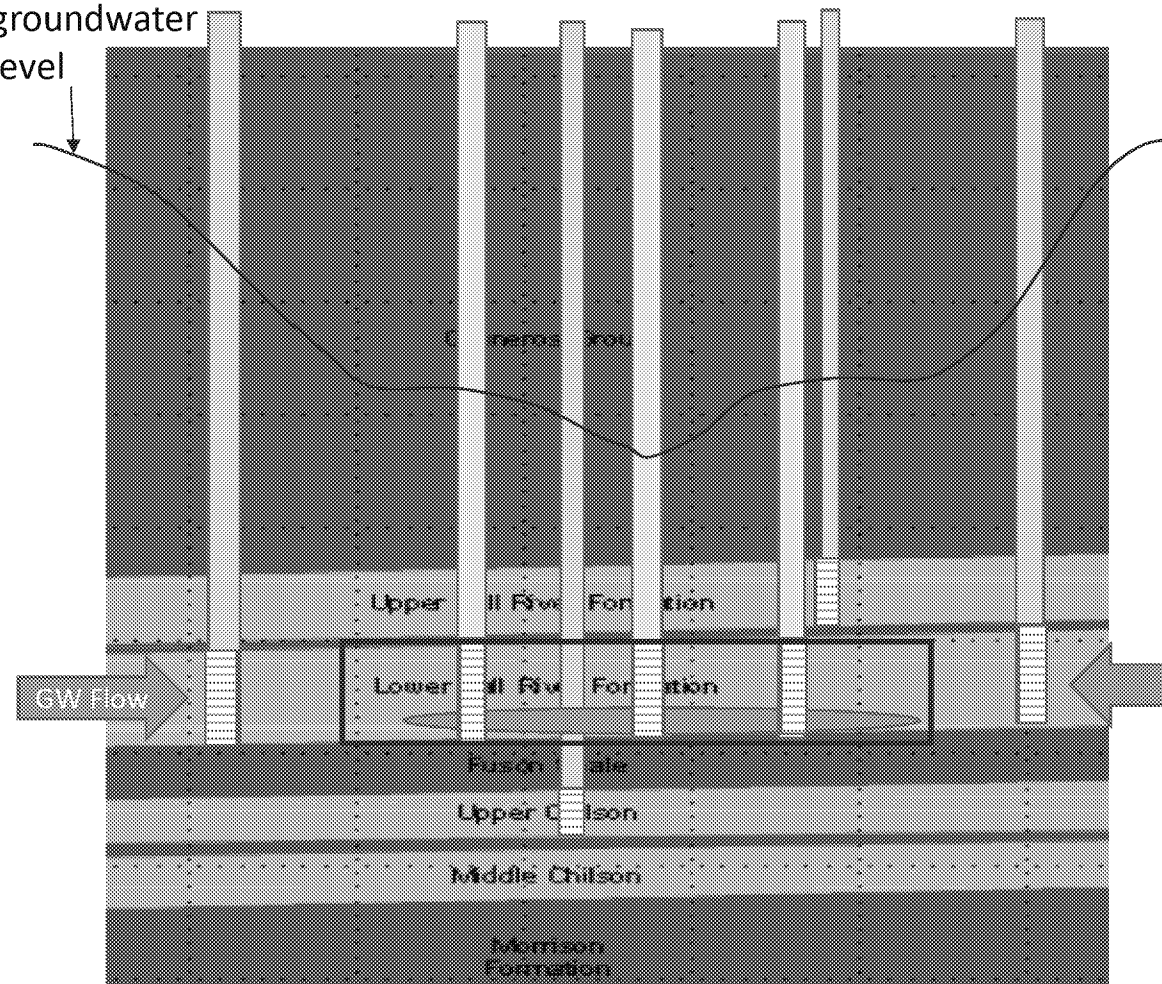


- cement
- well casing

# The Life of a Wellfield

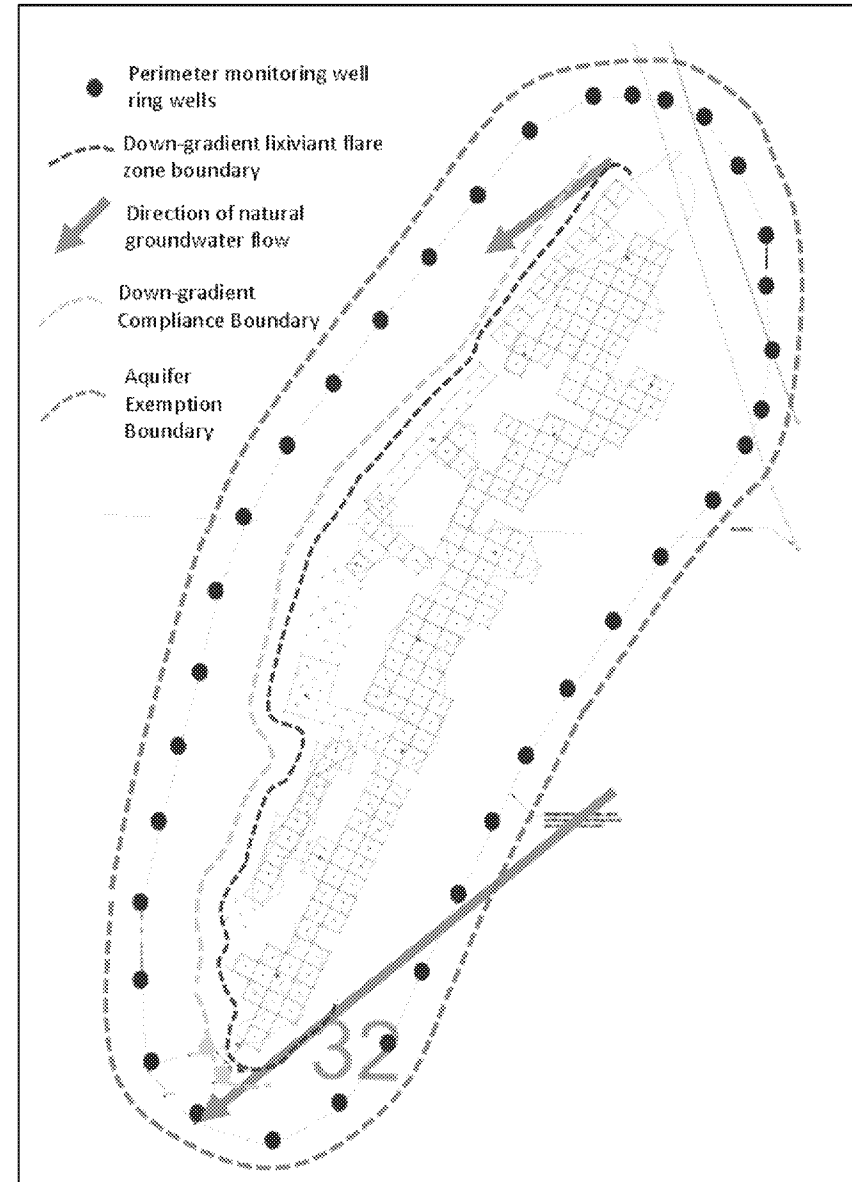
1. Uranium extraction in a wellfield takes about 2 years to complete.
2. Then NRC-regulated groundwater restoration begins.
3. Groundwater restoration continues until the groundwater is cleaned-up to pre-ISR or NRC-approved concentrations.
4. The NRC determines that groundwater restoration is complete.
5. The natural groundwater flow gradient restores itself.
6. After that the EPA Class III permit requires the Permittee to begin post-restoration groundwater monitoring to show that ISR contaminants do not cross the aquifer exemption boundary.

Lower Fall River  
groundwater  
level

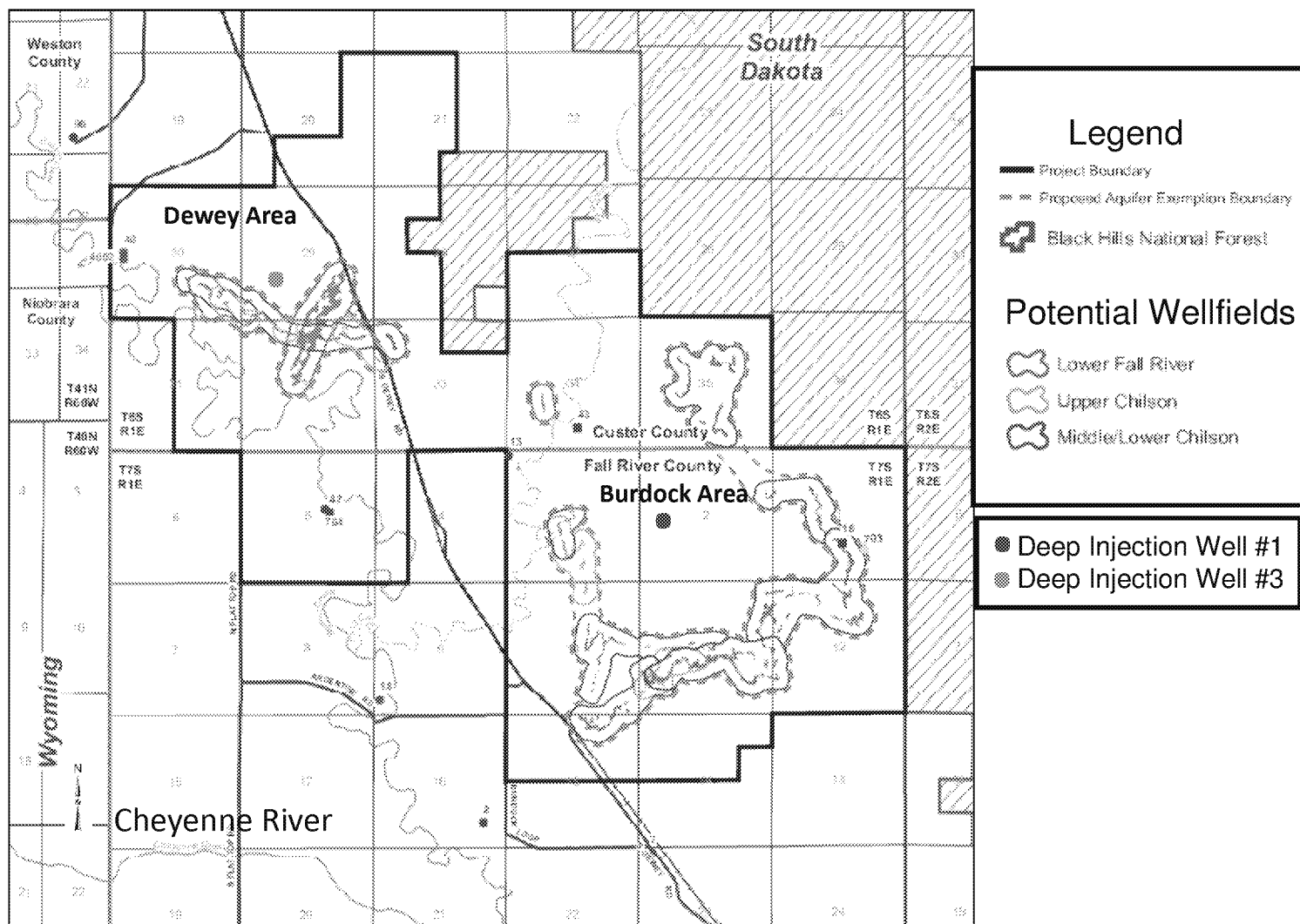


# Post-restoration Monitoring

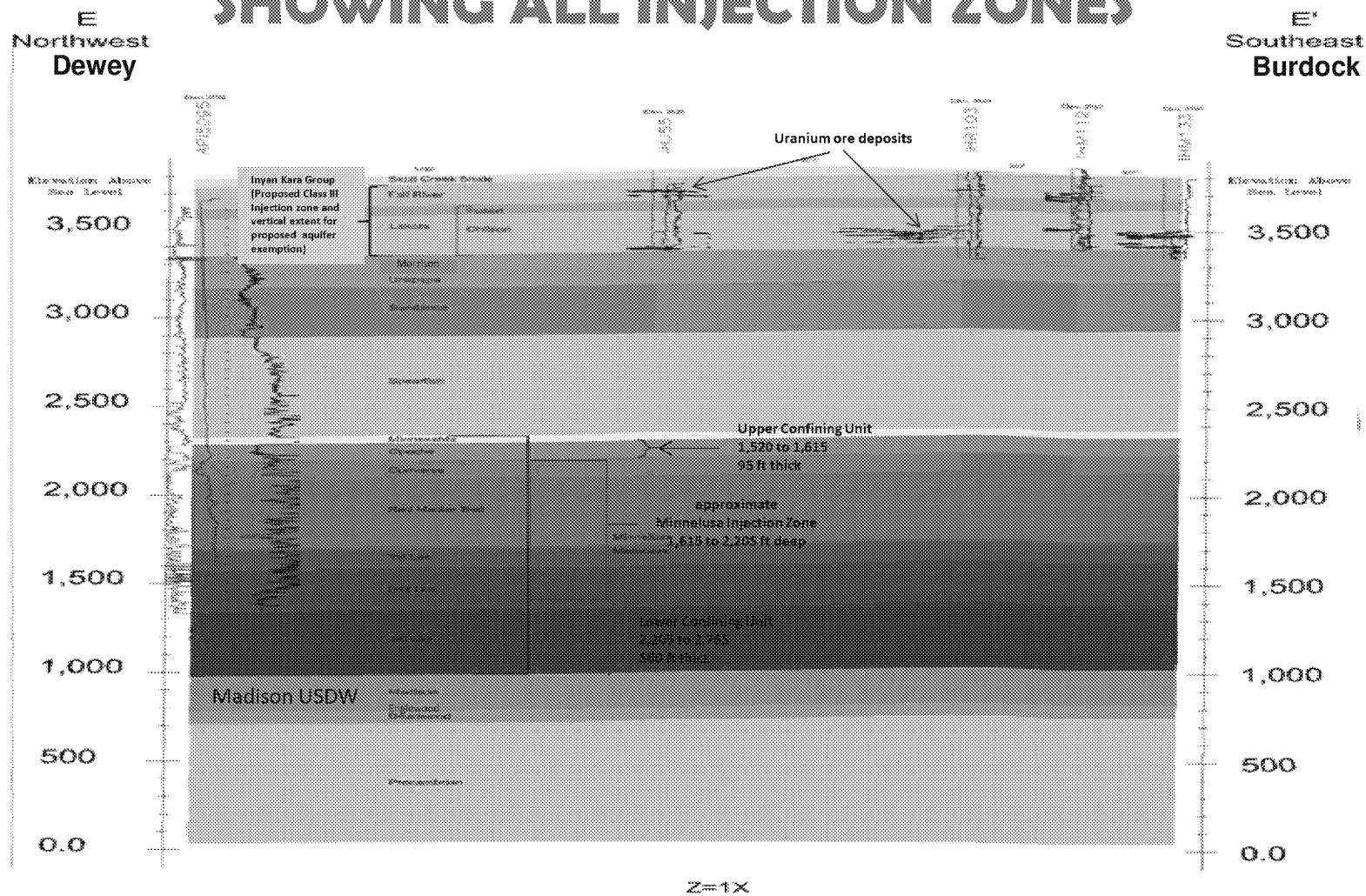
1. Post-restoration monitoring plan includes establishing a down-gradient compliance boundary.
2. Groundwater baseline constituent concentrations are used as the permit limits for determining that no ISR contaminants cross the aquifer exemption boundary.
3. The Permittee must demonstrate that no ISR contaminates cross the down-gradient compliance boundary.
4. This requirement is new to the ISR industry.
5. If ISR contaminants are detected at the down-gradient compliance boundary, the Permittee must establish a new boundary and perform remediation.
6. It is a permit violation if ISR contaminants cross the aquifer exemption boundary and groundwater remediation is required.



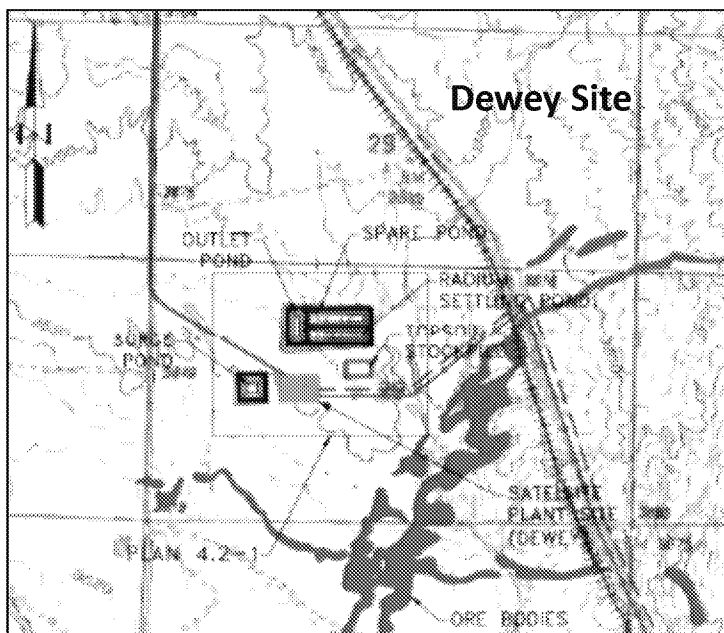
# Dewey Burdock Proposed Deep Disposal Wells



# GEOLOGIC CROSS SECTION SHOWING ALL INJECTION ZONES

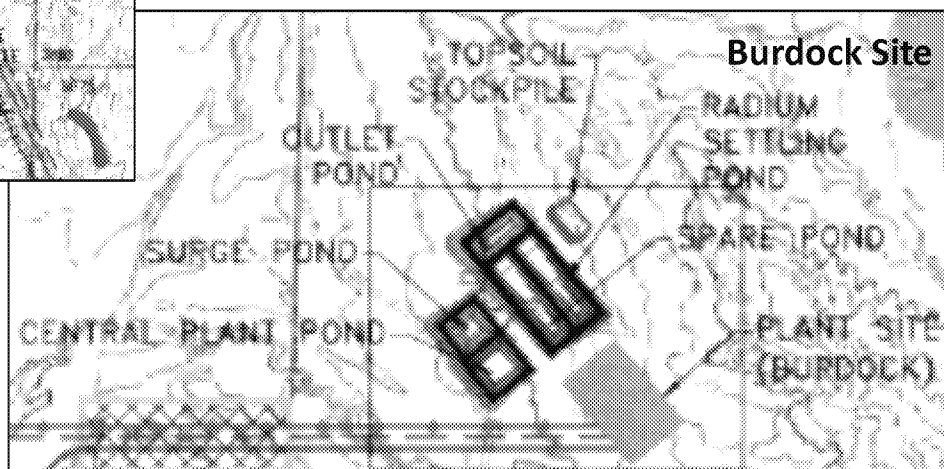


## Treatment and Storage Ponds for Deep Well Injectate



Waste fluids from the uranium recovery process will be treated in the radium settling ponds. After radium removal, the treated water will be stored in the outlet ponds and surge ponds. There will also be a spare radium treatment pond for backup. After treatment, the water will flow to the deep injection wells.

The Burdock Area central plant pond will store brine from the reverse osmosis treatment process used during groundwater restoration before the brine is treated in the radium settling ponds.





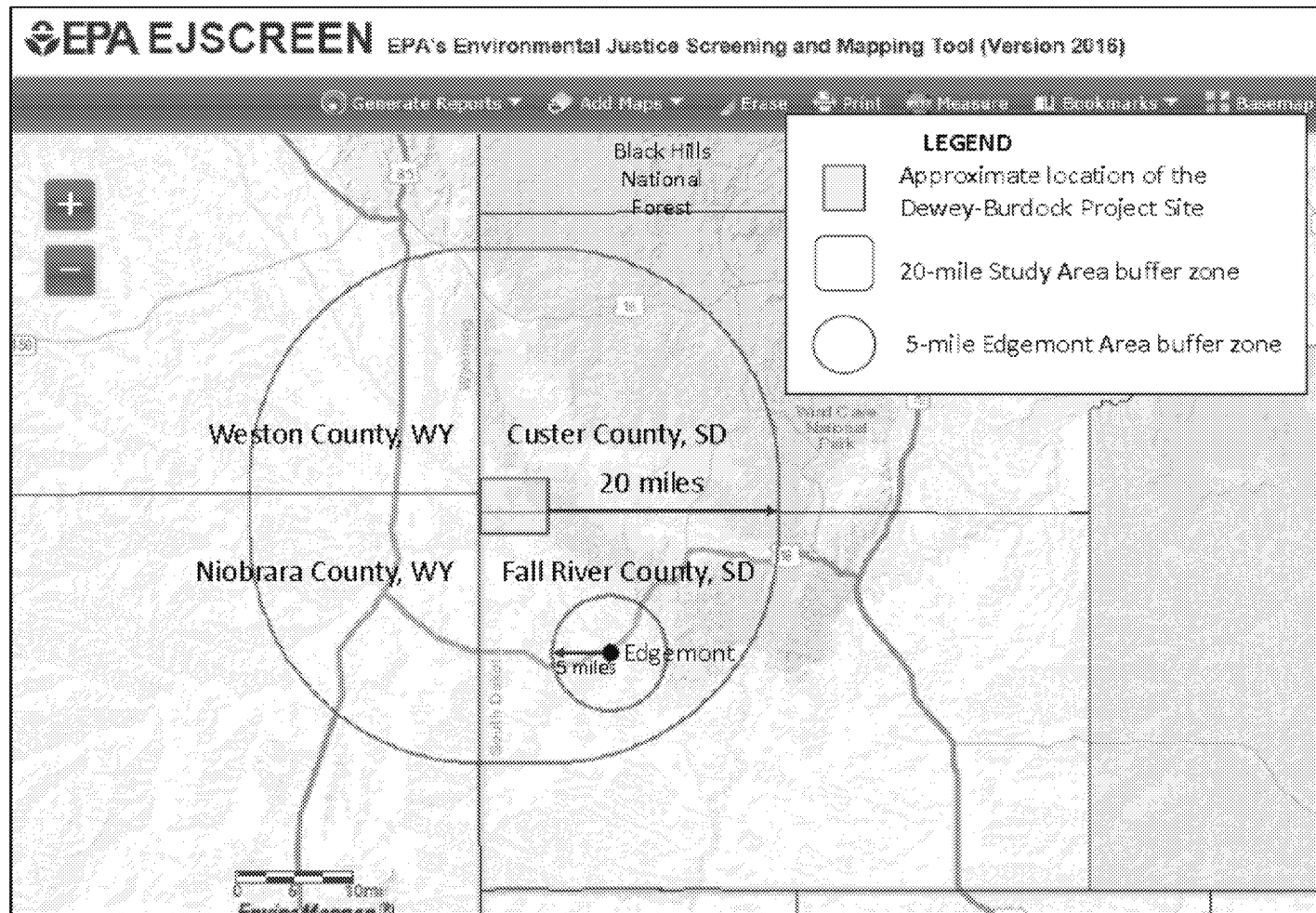
# **Class V Draft Area Permit Requirements**

- Testing of the Minnelusa aquifer to confirm it is not a USDW. (The EPA will not authorize injection into a USDW.)
- Class I (the most protective) well construction standards.
- Extensive characterization of hydrogeology before the EPA will issue authorization to inject.
- Continuous monitoring of the fluid between the injection tubing and well casing for early detection of any injection tubing leaks.
- Treatment of the injectate to meet radioactive waste standards set in the NRC regulations (treatment using barium chloride to precipitate radium from the waste fluids in settling ponds).
- Treatment to meet hazardous waste standards (arsenic, barium, cadmium, lead, mercury, selenium and silver).

## **Tribal Consultation Efforts to Date**

- Mailed request for consultation to 38 tribes in Regions 5, 6, 7 and 8.
- Eight tribes responded and requested consultation meetings.
- We held consultation meetings with seven of the eight tribes before the draft permits were issued.
- Four tribes have requested consultation meetings now that the draft permits have been issued.
- One important issue is a survey of traditional cultural properties at the site.
- A second important issue is identifying potential changes tribes would like to see in the NRC Programmatic Agreement.

# Environmental Justice Analysis



# Cumulative Effects Analysis

Areas where the EPA Evaluated Impacts Potentially Resulting from the  
Drilling and Operation of Injection Wells Authorized under UIC Area Permit

Impact Areas Investigated
Impacts to USDWs (water quality and quantity)
Impacts to surface water and wetlands
Impacts from spills and leaks
Impacts to land use
Impacts to soils
Impacts to geology
Potential radiological impacts and effluent control systems
Impacts to Air Quality
Climate change impacts
Transportation Impacts
Impacts from Potential Accidents
Impacts to Ecological Resources
Impacts from Waste Management

# **Ponca Tribe of Nebraska Consultation Topics:**

- Sacred sites
- Water
- Plants
- Wildlife and livestock, and
- Human beings that could be impacted in a negative way.

# **Ponca Tribe of Nebraska Consultation Topics:**

## ➤ Sacred sites

- ❖ NHPA Section 106 Consultation.

- ❖ During consultation:

- Identification of traditional cultural properties, including sacred sites.
- Identification of potential impacts to traditional cultural properties.
- Identification of mitigation measures.

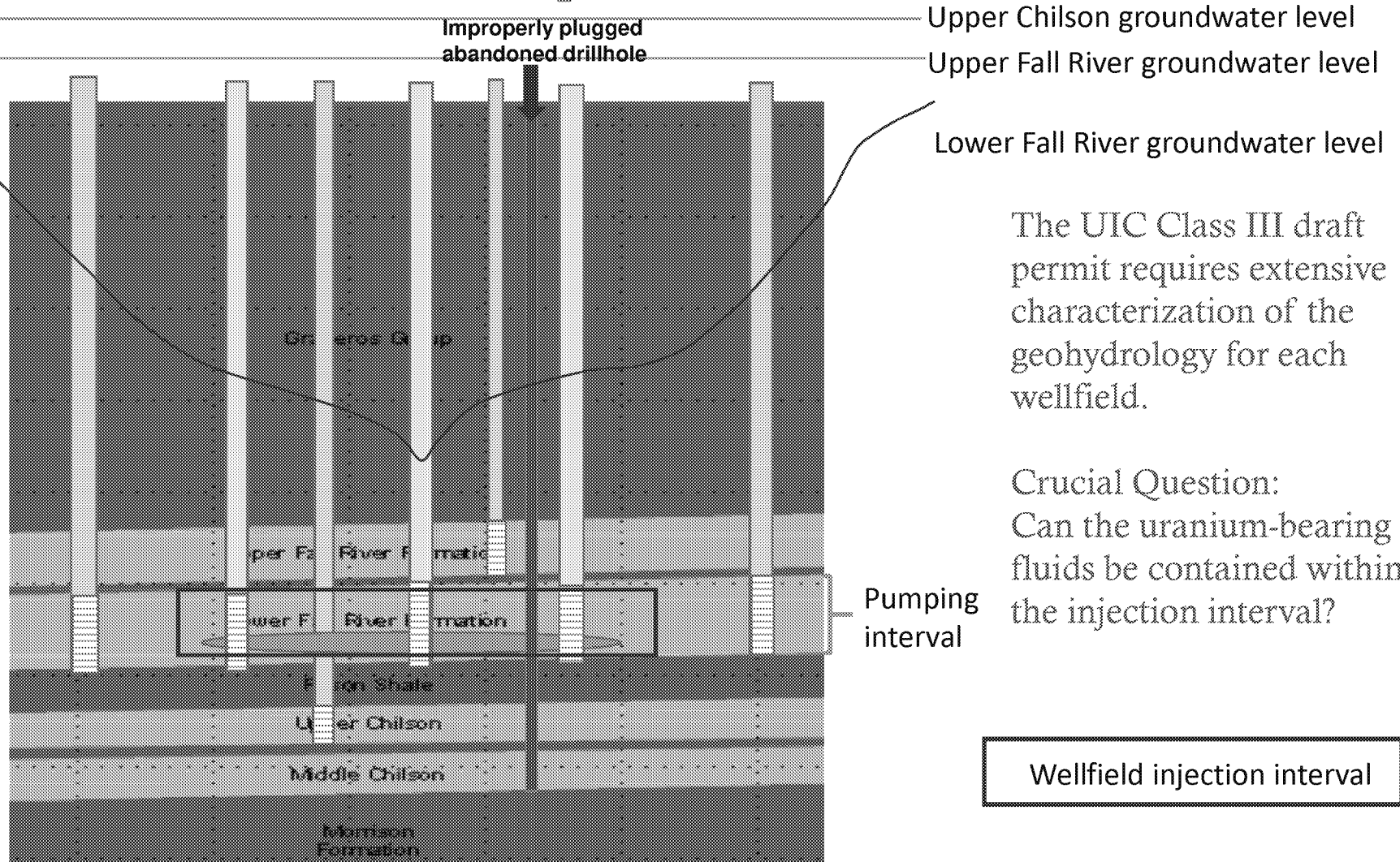
# **Ponca Tribe of Nebraska Consultation Topics:**

## ➤ Water

### ❖ Groundwater

- Characterization of geology (confining zones).
- Characterization of hydrological conditions (wellfield pump tests).
- Additional requirements for horizontal (injection zone) excursion monitoring.
- Additional requirements for monitoring to demonstrate no ISR contaminants cross the aquifer exemption boundary into the USDW.
- Additional requirements for groundwater remediation if ISR contaminants cross the aquifer exemption boundary into the USDW.

# Wellfield Pump Tests



The UIC Class III draft permit requires extensive characterization of the geohydrology for each wellfield.

Crucial Question:  
Can the uranium-bearing fluids be contained within the injection interval?



# Ponca Tribe of Nebraska Consultation Topics:

## ➤ Water

### ❖ Surface water

- Characterization of geology (confining zones)
- Characterization of hydrological conditions (wellfield pump tests)
  - Ensures that any pathways that would allow injection zone fluids to migrate to the surface are properly plugged.
  - Investigated project area for the presence of springs where injection zone fluids could potentially migrate to the surface.
  - There are no natural springs within the project area.
  - Powertech identified an area where an improperly plugged borehole is causing ponding on the ground surface.
  - The Class III area permit requires that improperly plugged boreholes within wellfield areas be plugged to prevent pathways to the ground surface.

# **Ponca Tribe of Nebraska Consultation Topics:**

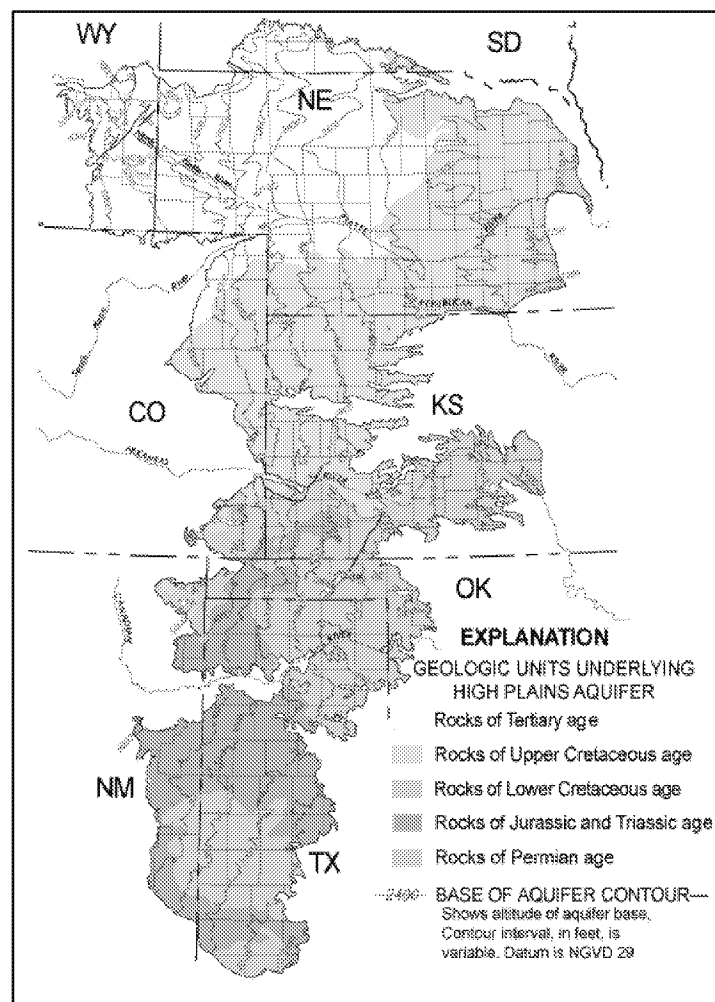
## ➤ Water

### ❖ Surface water

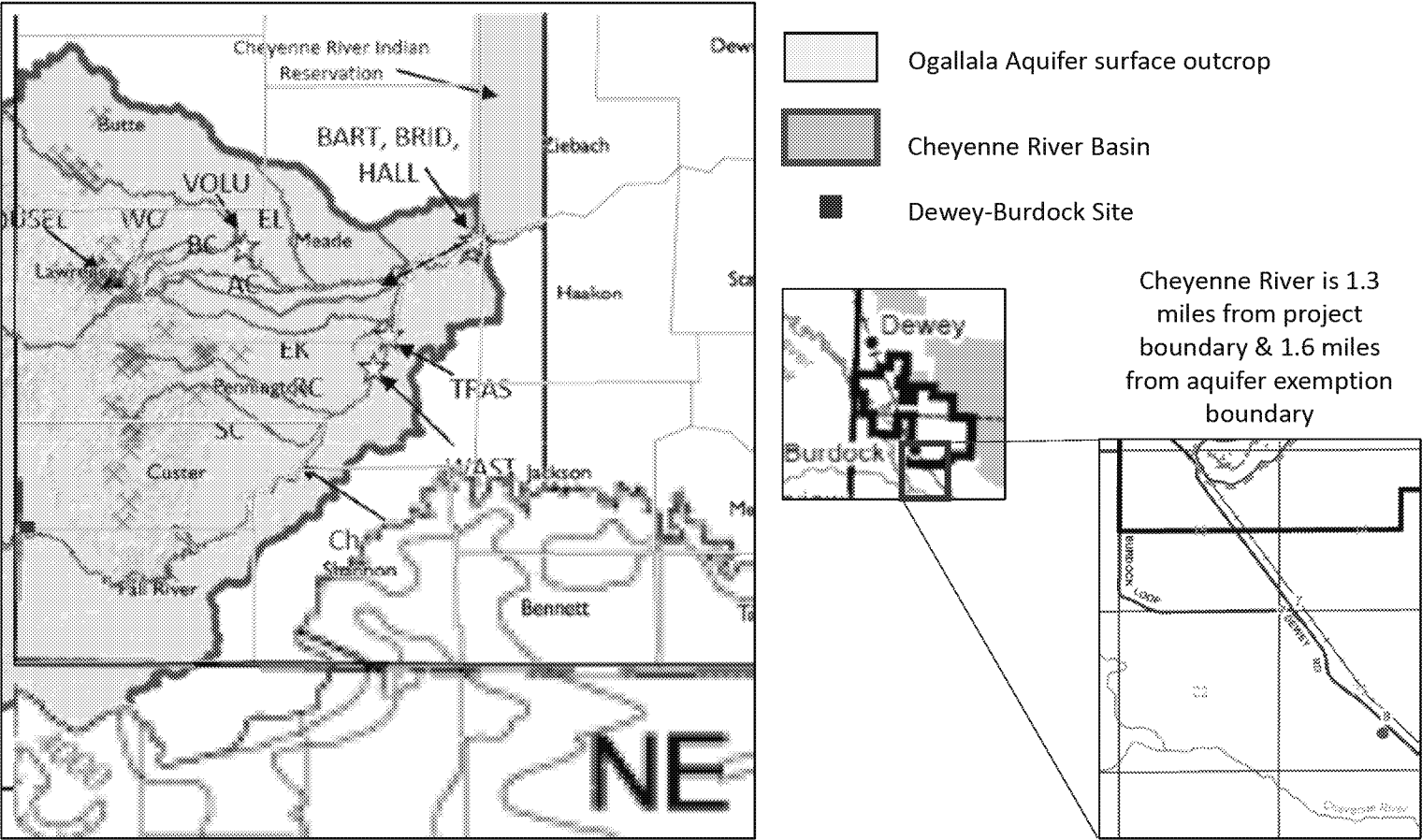
- Additional requirements for vertical (including overlying aquifers) excursion monitoring.
- Cumulative effects analysis of potential impacts to surface water and wetlands.
- The EPA must rely on State and 404 permits to protect surface water and wetlands.
  - Surface water monitoring stations.
  - Army Corps of Engineers 404 permits.
  - Stormwater permits to prevent floodwater impacts to treatment ponds.

### ❖ Investigation of the Ogallala Aquifer

# Extent of the Ogallala Aquifer



# The Extent of the Ogallala Aquifer & the Cheyenne River Basin



# **Ponca Tribe of Nebraska Consultation Topics:**

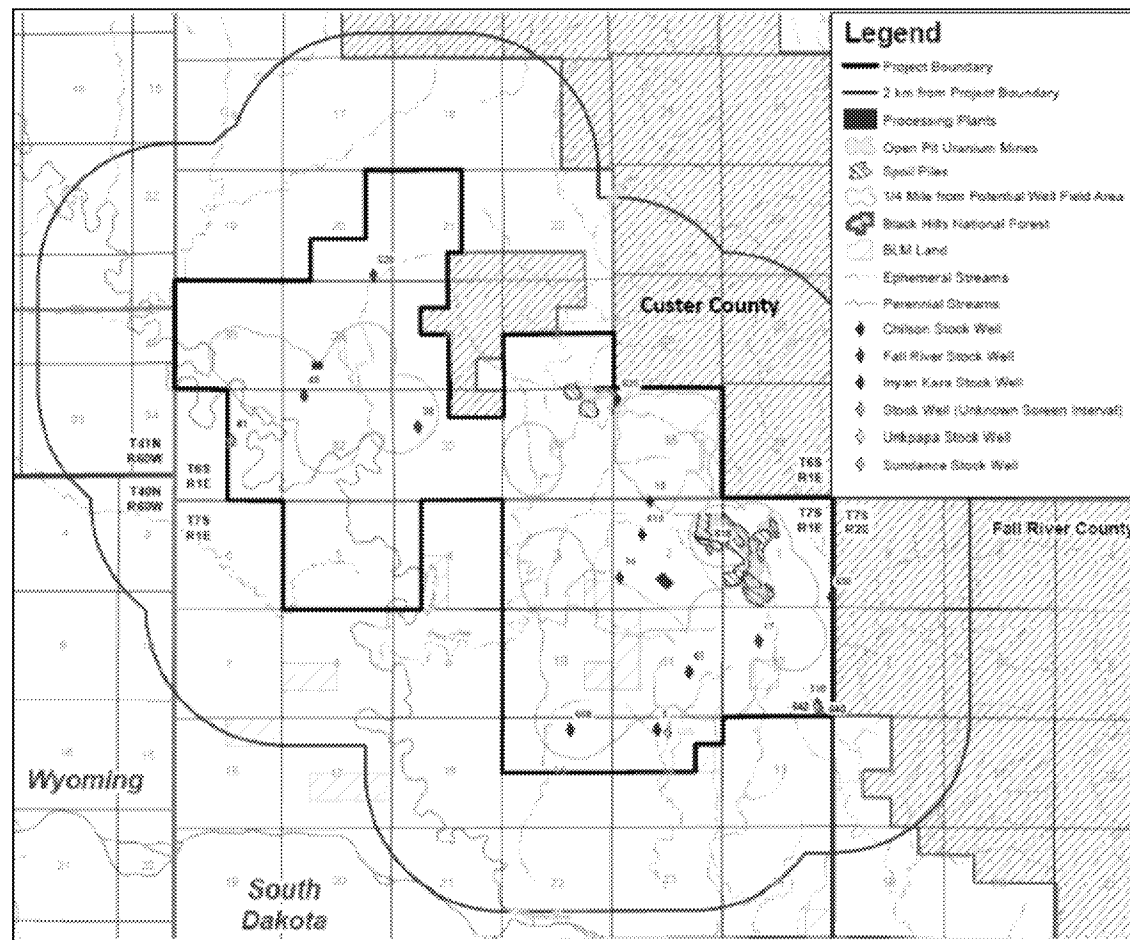
## ➤ Wildlife

- ❖ Compliance with the Endangered Species Act requirements for review.
- ❖ Review of protective measures in the Cumulative Effects Analysis document.
- ❖ Protective requirements under state permits.

## ➤ Livestock

- ❖ Powertech plans to replace wells inside the project area and provide water from Madison wells.

# Operational Groundwater Monitoring



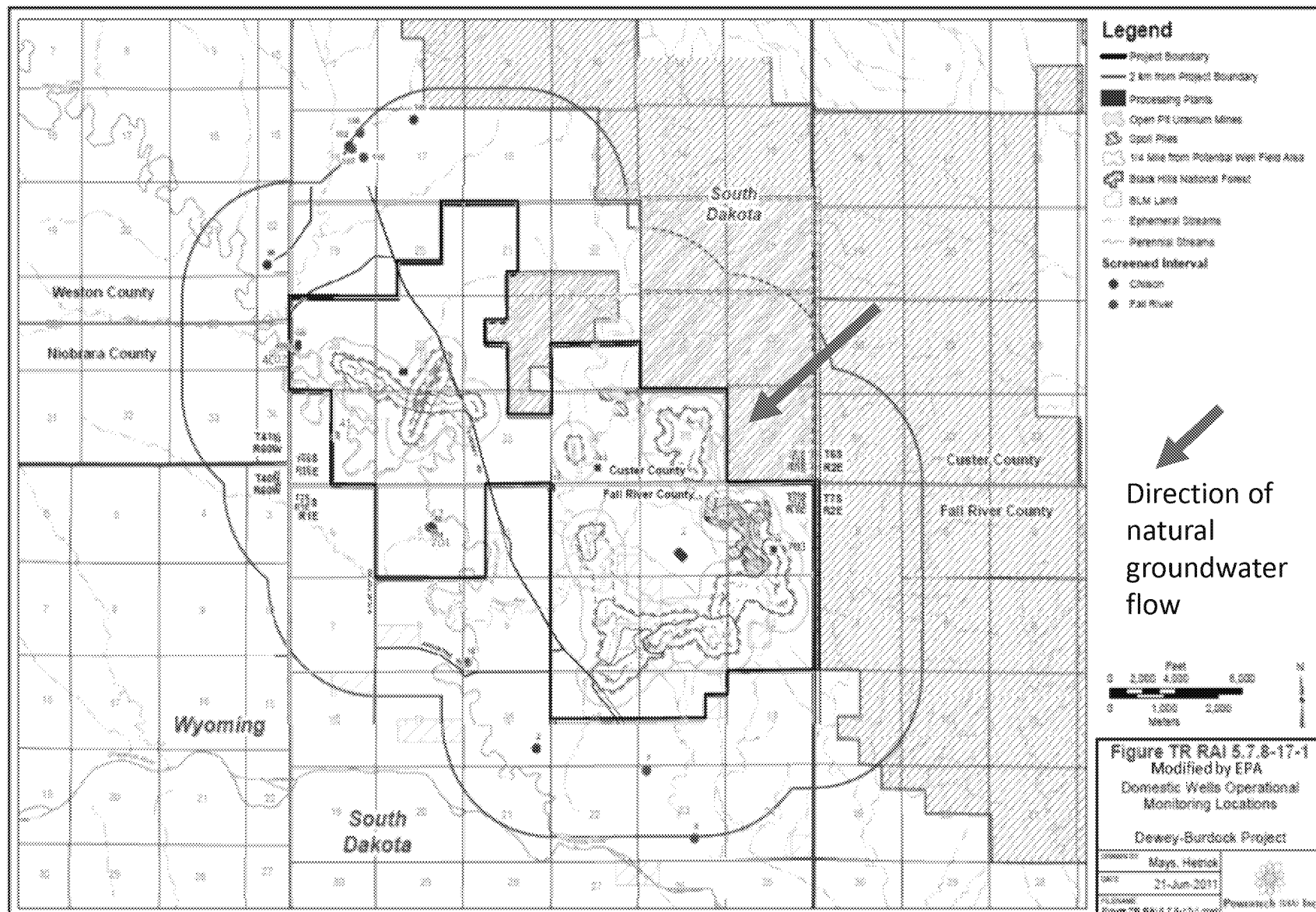
## Stock Watering Wells

# **Ponca Tribe of Nebraska Consultation Topics:**

- Human beings that could be impacted in a negative way.
  - ❖ Review of nearby drinking water wells
    - Evaluation for likelihood of impacts
    - Capture zone analysis for downgradient and cross-gradient wells
  - ❖ Operational groundwater monitoring required by Class III permit

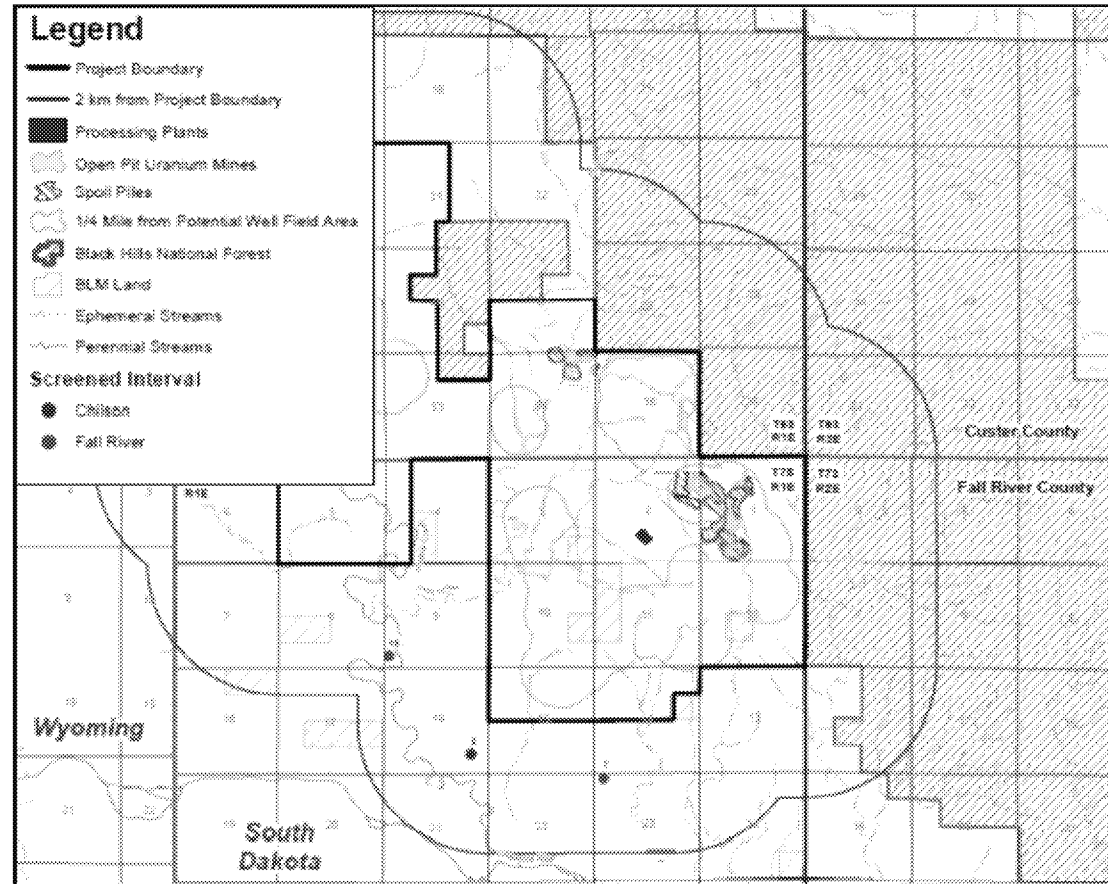
# Private Drinking Water Wells

Nineteen Private Drinking Water Wells within the Dewey-Burdock Project Area of Review.





# Operational Groundwater Monitoring

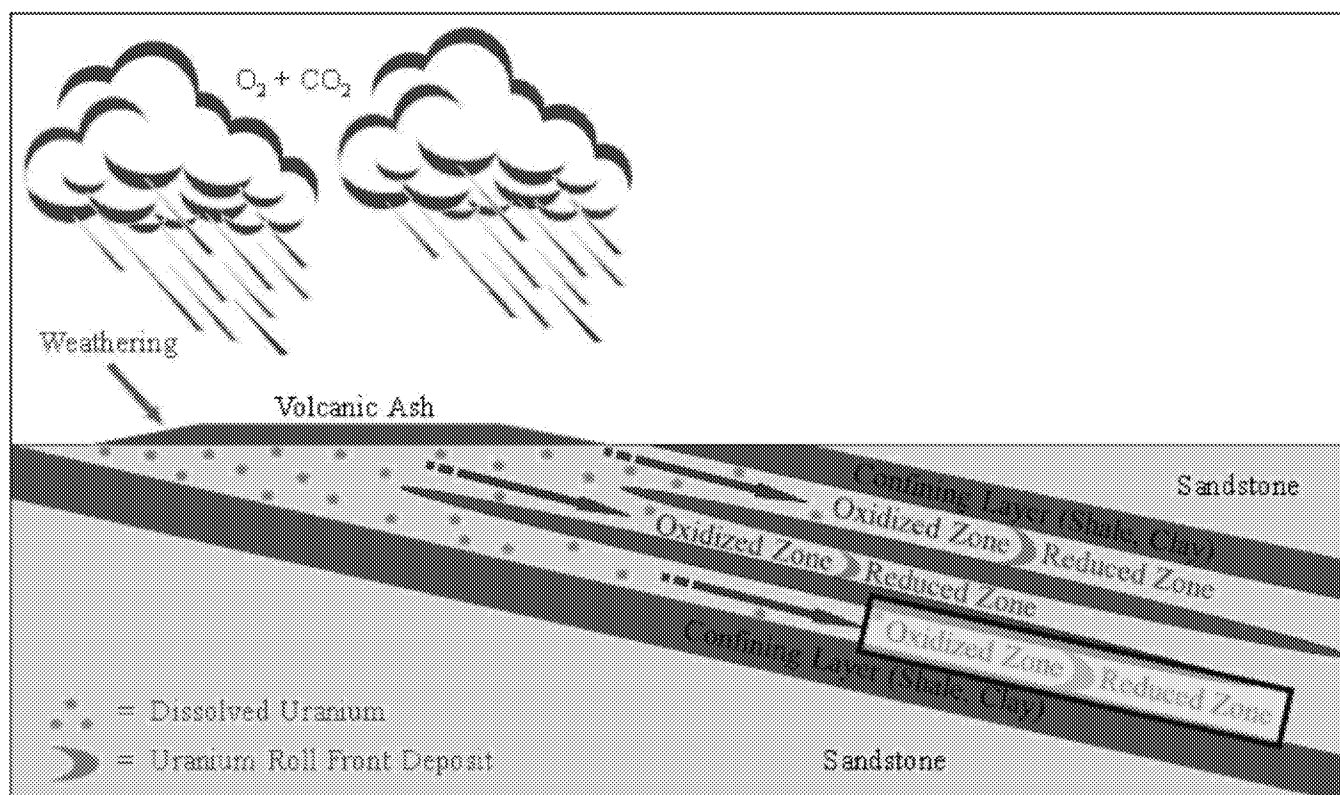


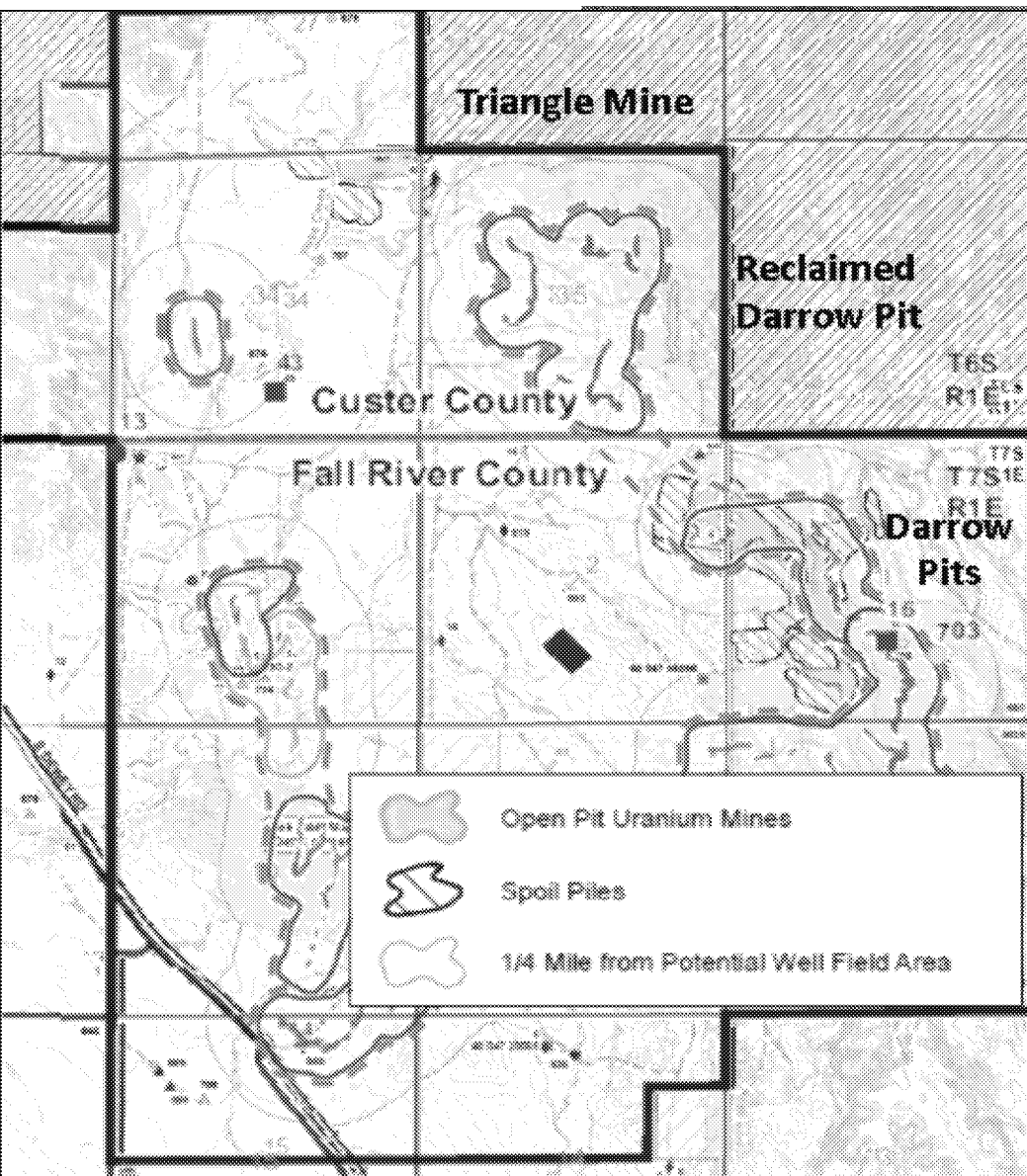
Three Domestic Wells: Hydro IDs 2, 7 and 18  
Quarterly sampling; analyzed for baseline constituents

# Baseline Water Quality Parameter List

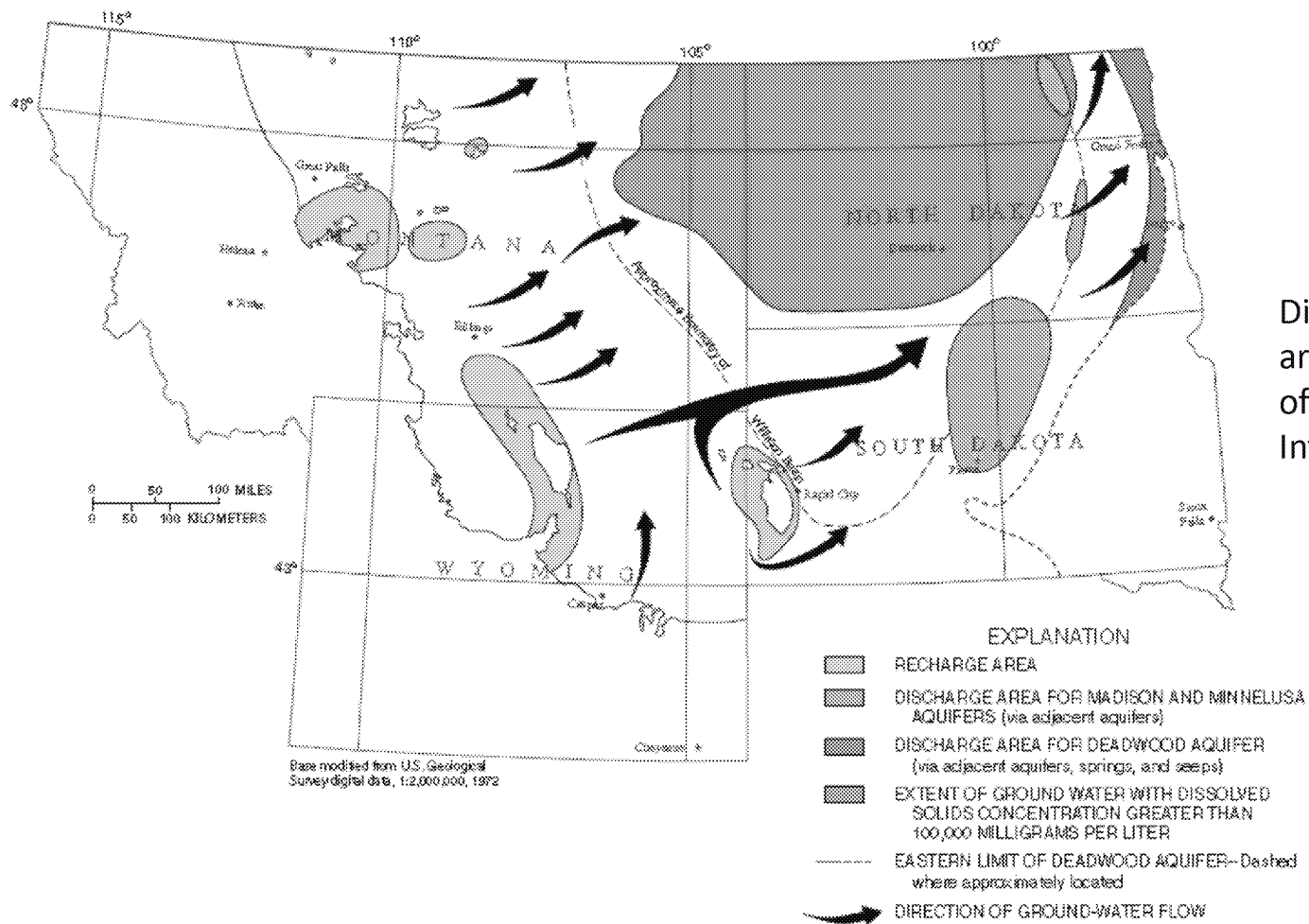
Test Analyte/Parameter	
Physical Properties	Total Metals
pH <sup>3</sup>	Aluminum, Al
Total Dissolved Solids (TDS)	Antimony, Sb
Specific Conductance <sup>3</sup>	Arsenic, As
Common Elements and Ions	Barium, Ba
Total alkalinity (as Ca CO <sub>3</sub> )	Beryllium, Be
Bicarbonate Alkalinity (as Ca CO <sub>3</sub> )	Boron, B
Calcium	Cadmium, Cd
Carbonate Alkalinity (as Ca CO <sub>3</sub> )	Chromium, Cr
Chloride, Cl	Copper, Cu
Magnesium, Mg	Fluoride, F
Nitrate, NO <sub>3</sub> (as Nitrogen)	Iron, Fe
Potassium, K	Lead, Pb
Silica, Si	Manganese, Mn
Sodium, Na	Mercury, Hg
Sulfate, SO <sub>4</sub>	Molybdenum, Mo
Radiological Parameters	Nickel, Ni
Gross Alpha	Selenium, Se
Gross Beta	Silver, Ag
Gross Gamma	Strontium, Sr
Lead 210	Thallium, Tl
Polonium 210	Thorium, Th
Radium, Ra-226	Uranium, U
Thorium 230	Vanadium, V
	Zinc, Zn

# Roll-Front Formation



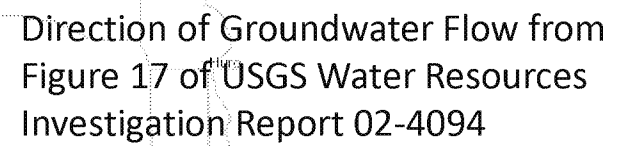


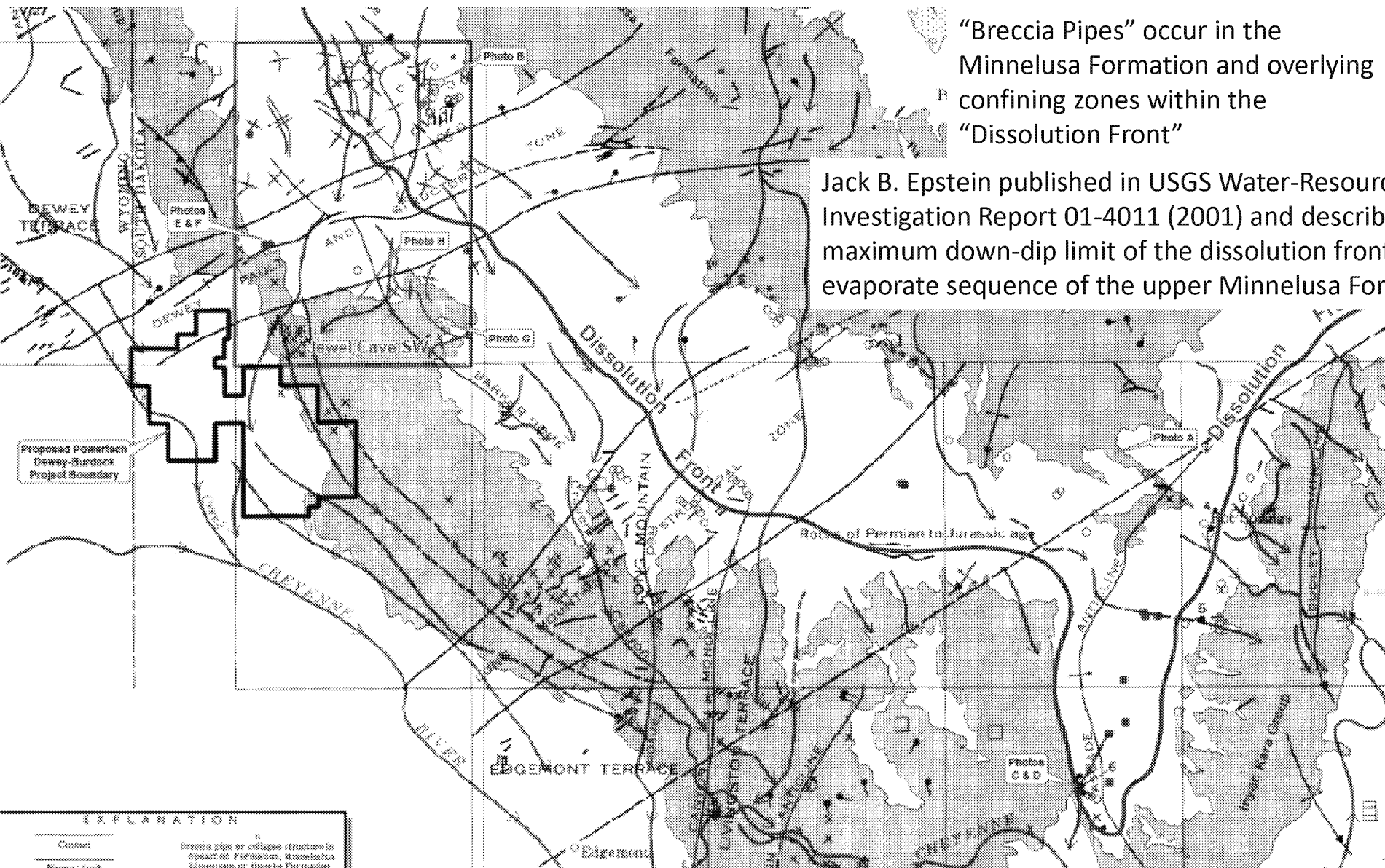
**Abandoned Uranium Open Pit Mines  
in NE Burdock Area**

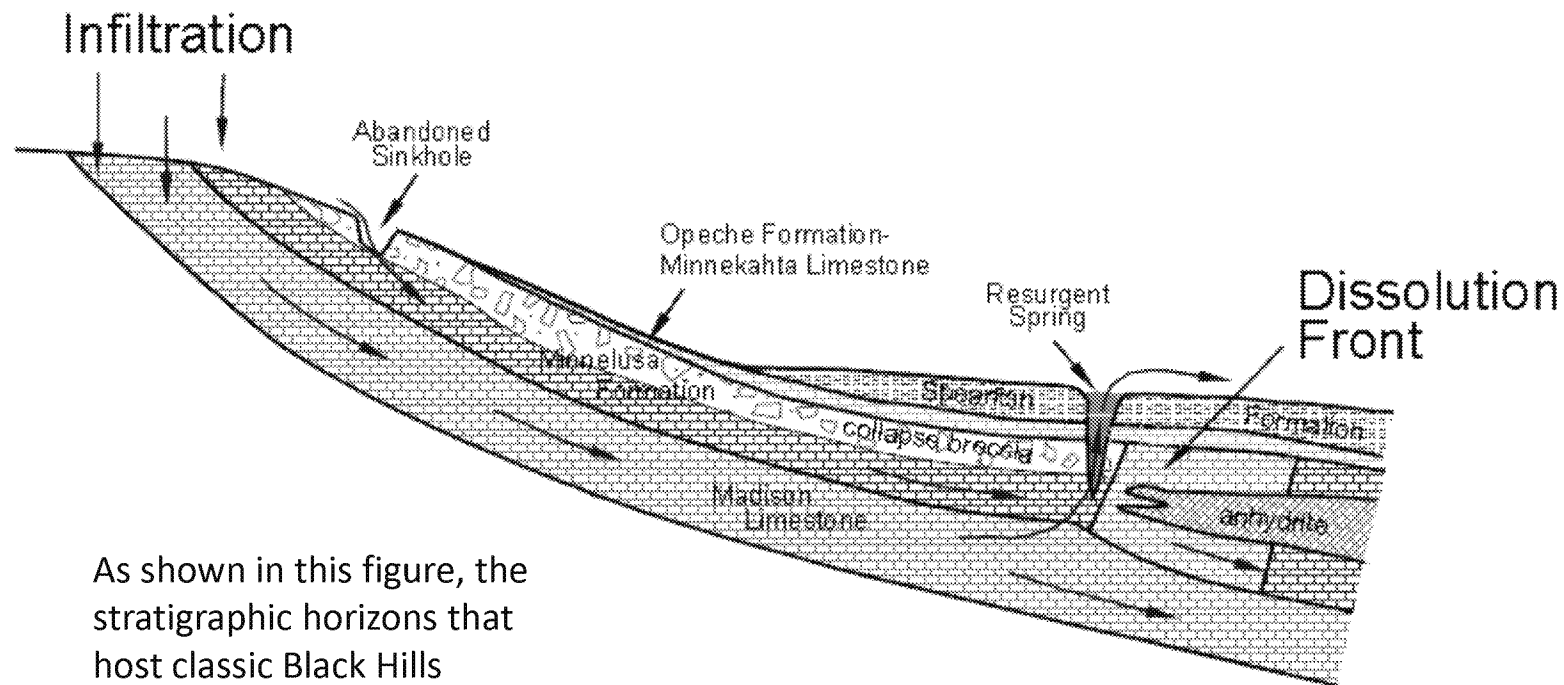


Direction of Groundwater Flow around the Black Hills from Figure 17 of USGS Water Resources Investigation Report 02-4094

**Figure 17.** General direction of ground-water flow in regional aquifer system within Paleozoic aquifer units (modified from Downey and Dinwiddie, 1988; Whitehead, 1996).







As shown in this figure, the stratigraphic horizons that host classic Black Hills breccia pipes are the upper Minnelusa Formation, Opeche Shale, Minnekahta Limestone and the lower 200 feet of the Spearfish Formation.

**Figure 1**

Minnelusa Dissolution Front  
Southern Black Hills  
South Dakota  
Dewey-Burdock Project

DRAWN BY J. Bonner

DATE 17-Jul-2012

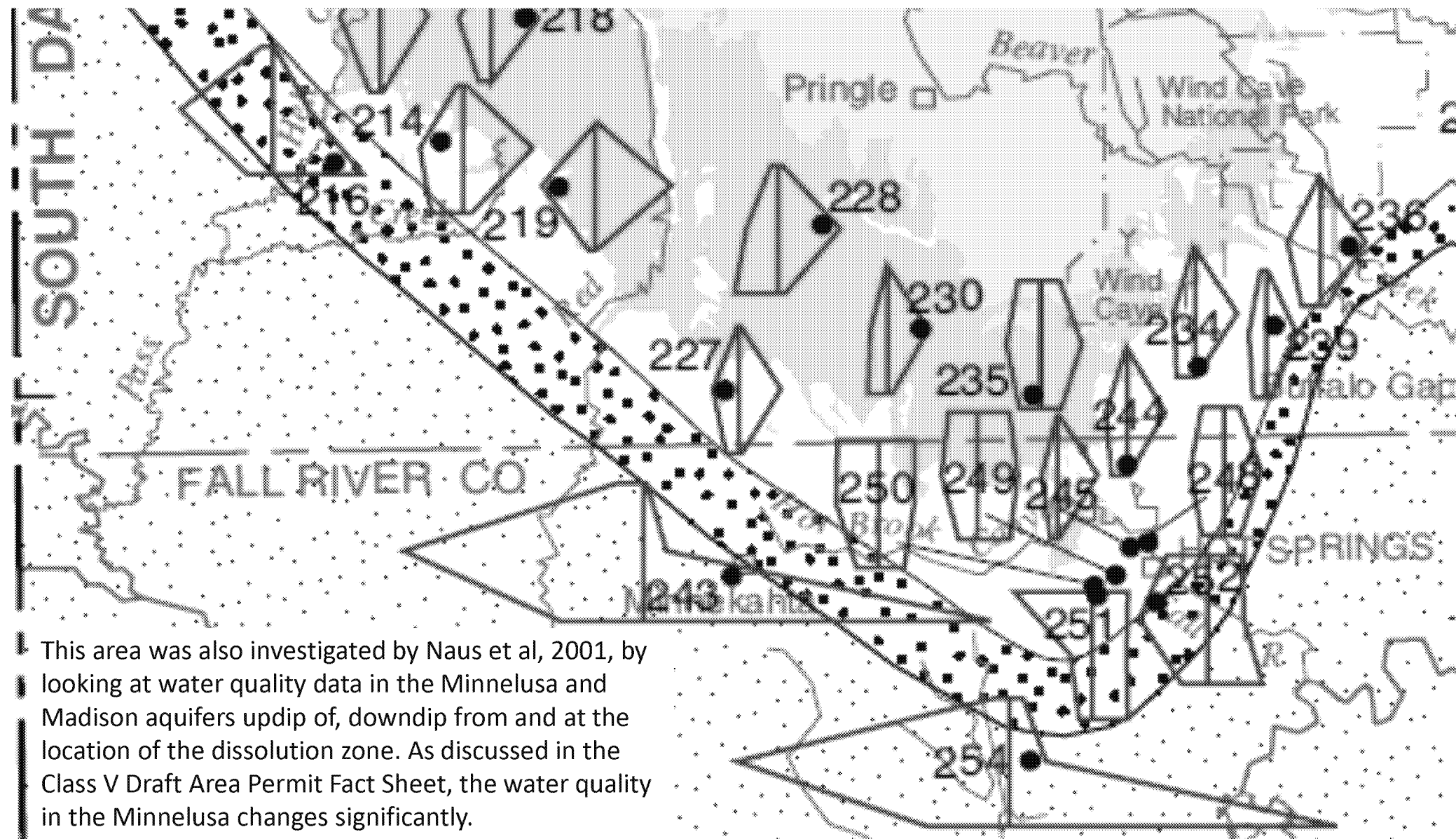
FILE NAME Minn Dis Front.dwg



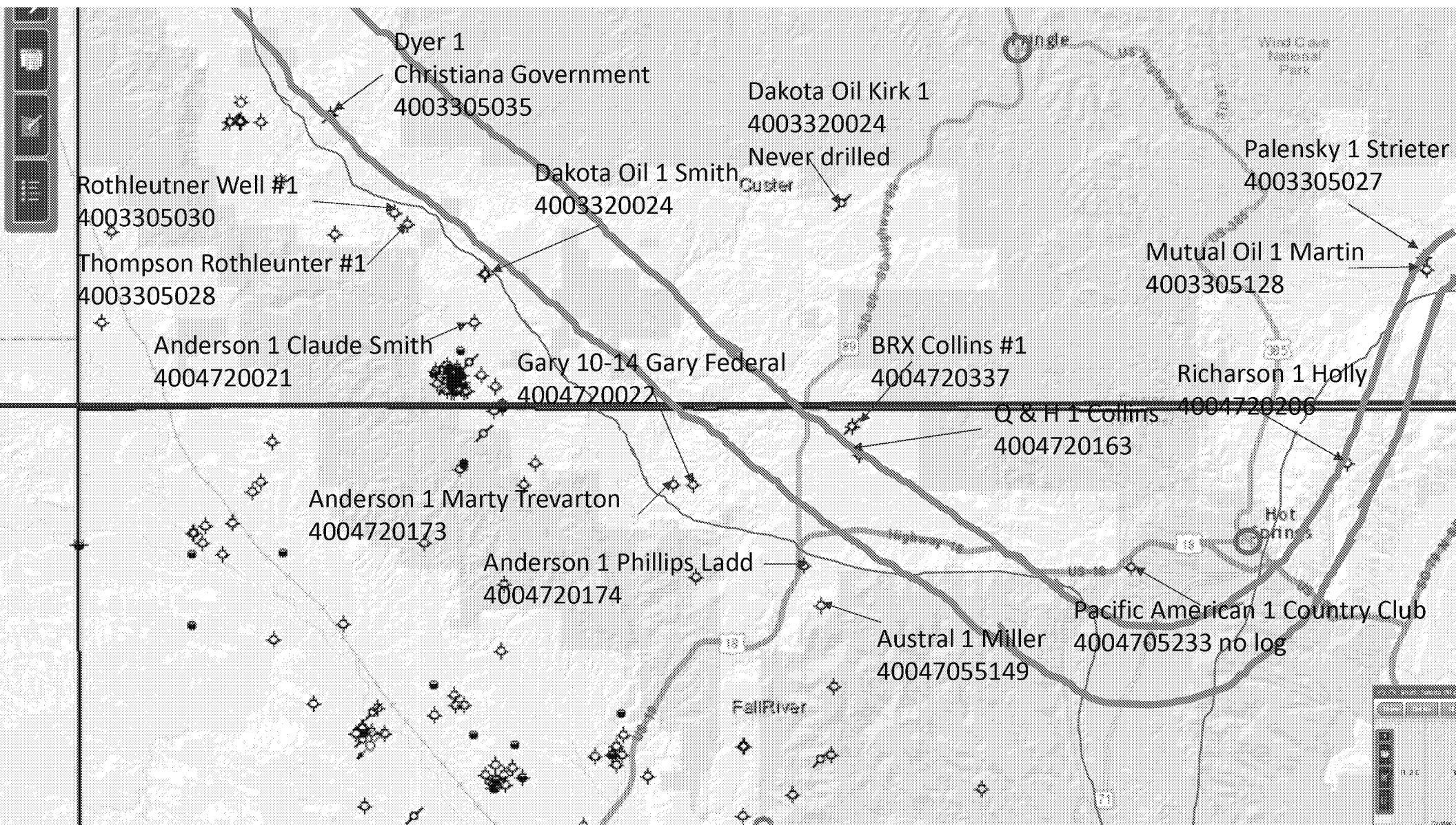
Powerstroke USA Inc.

Source: USGS Water-Resources Report 01-401, 2001, Jack B. Epstein, pp. 30-37





SV1





# Wellfield Operation

